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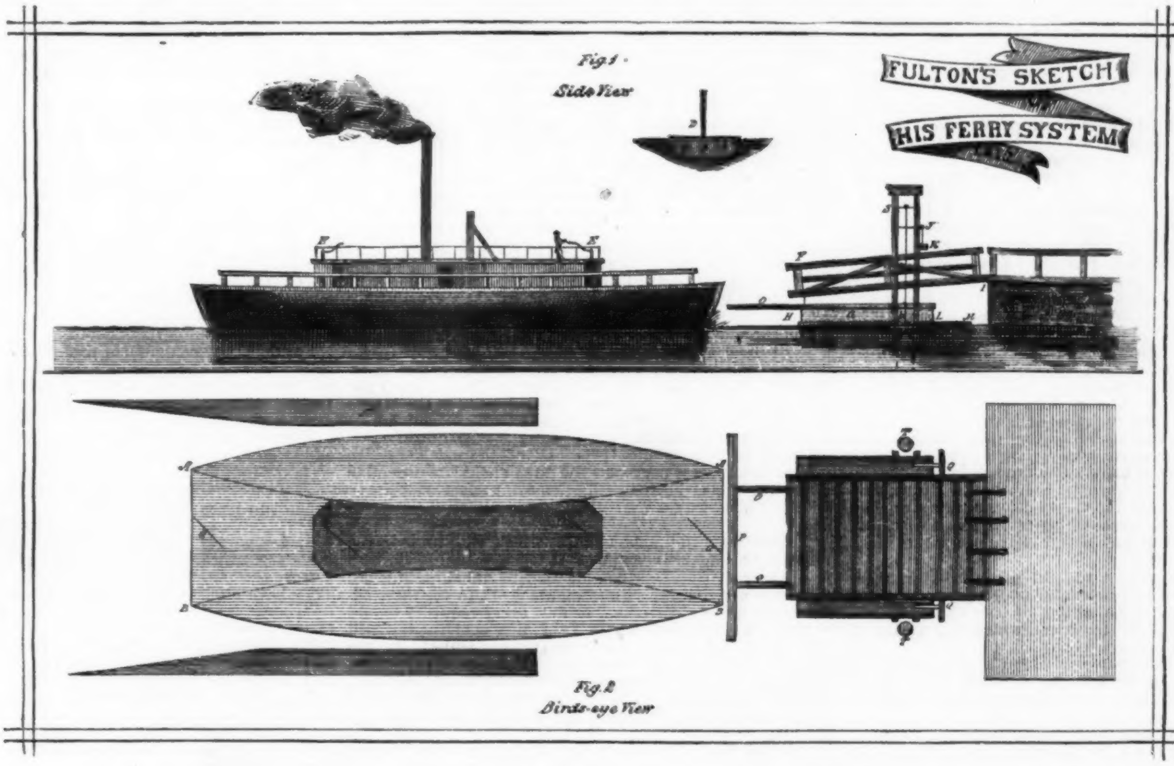
AMERICAN ENGINEERING.—V.*

INTERNAL NAVIGATION.

THE United States, early in its history, was noted for its clipper ships, which successfully competed for an important share of the commerce of the world, and as the population rapidly increased advantage was taken of the numerous great bays, rivers, and lakes to extend internal navigation in all directions. In due time important lakes and streams were connected by canals, several of considerable magnitude, though small in comparison with the natural water courses thereby united. The demands incident to the rapid development of the country and the individual freedom of thought and action stimulated enterprise and invention, and the means available were quickly utilized to overcome difficulties and accomplish the ends desired.

Under such circumstances steam navigation was developed. Fitch, in 1786, showed it to be practicable; Fulton, in 1806, put it in such shape that its great value was demonstrated and success assured. The ocean was crossed by steam for the first time by the American steamer Savannah, in the year 1819, and the Collins steamers, brought out about the year 1850, were the first in which the heavy head gear used on sailing vessels was dispensed with, reducing the pitching moments, and indicating the general characteristics of modern ocean steamers.



The steamers used in the internal navigation of different parts of the United States are very different in construction and appearance, being specially adapted for the several locations and the duties to be performed. In the sheltered bays and connecting rivers on the coast, side-wheel steamers are generally employed, with large, sharp hulls of light draught and little freeboard. The freight is in general stored on the main deck, and passengers are accommodated in cabins and staterooms above. The main deck is made much wider than the hull, extending to the outside of the paddle wheels, the overhanging portions being called the guards. The cabins are sometimes extended several stories in height, and furnished and fitted with all the comforts and luxuries of hotels and dwellings. The hulls are stiffened longitudinally at each side by an arched truss (hog frame), or centrally by a series of king-posts and diagonals, extending from stem to stern. Each boat is in general propelled by the typical American beam engine, with skeleton trussed beam supported by a wooden gallows frame. This form gives ample length of connections, and the necessary flexibility and distribution of strain and weight to permit maximum power to be used continuously in a light hull. The single engine is so narrow that, when inclosed, broad passages are left on each side to connect the forward and after cabins and compartments. In smaller boats, a single boiler is placed below decks. In large, shallow steamers, like those used on the Hudson River, the boilers are placed on the guards. In steamers admitting greater draught, like those used on Long Island Sound, the boilers are placed either on the guards or in the hold. Blowers are generally used to hasten combustion or to permit the use of anthracite pea coal. Some of the larger steamers of later construction have sufficient boiler power with natural draught. Boats making short trips on bays connected with the sea, carry fresh water in tanks for use in the boiler. Those making longer runs, often have surface condensers.

Steamers of this kind are adapted for use on routes along the sea coast and up navigable rivers by simply increasing the depth of hold, and sometimes dispensing with the guards, the freight being stowed below the main deck. The upper cabins are modified according to the average exposure during the sea voyage. Light draught propellers of similar construction are also used on this duty. Propellers are principally used on the great lakes, some being of large size; the draught, however, is restricted to about 14 feet, to pass the flats at Lake St. Clair. Propellers of this kind are used to tow one to four or more barges or schooners loaded with freight.

On the Mississippi River and its network of connecting rivers and bayous, the steamers are of very peculiar construction. The fluctuations in the depth of water on the bars require very light draught, measured, for many streams, by inches, instead of feet. The hulls are shallow, with flat bottoms, the ends sharpened more or less, but generally shaped to throw the water beneath. The main deck receives the machinery and freight, and supported by posts at a considerable distance above it are a series of cabins, reducing in size as they rise, till the "Texas" and pilot house tower over all, just behind two high smoke pipes, from which, when in use, black smoke, and sometimes flame, belch forth; the general appearance, together with the noise of the exhaust steam from the high-pressure engines, makes a lasting impression on the memory. The machinery consists of two horizontal engines, connected one to each side-wheel, or each to a crank at each side of a stern-wheel. The steam cylinders are long and of comparatively small diameter; the bed-plates are wood; the connecting rods or pitmans of wood strapped with iron; the whole stretched out to distribute the weight as much as possible, and yet located at the sides, so as to be out of the way. The independent arrangement of the two engines enables the pilot to maneuver the boat by the wheels, even more than by the rudder. The steam pressure carried is usually about 150 pounds per square inch. The steam cylinders are fitted with single poppet valves, and steam is cut off by a cam at about half stroke. The feed water is heated by the exhaust steam. The boilers are cylindrical, set in brick work; they are externally fired, and the products of combustion return through two flues in each. Yet these apparently crude constructions have, by years of experience, been found best adapted for navigation in the shallow Western rivers containing much sediment. Tubular boilers could not be made to stand, and iron framing or more condensed machinery would strain the boat or increase the dead weight and draught of water.

The cabins of passenger boats are well fitted up and are airy and comfortable, and the steamers do continuous satisfactory work in locations where it would be impossible to operate craft of more elaborate design. Some boats, of from 1,200 to 2,400 tons, "stern-wheelers," run between Cincinnati and St. Louis and New Orleans exclusively as freight boats.

Tow boats, which are all of the stern-wheel class, are 160 to 240 feet long, 30 to 40 feet beam, and draw 3½ to 8 feet water. They carry only fuel, and are provided with powerful machinery. They are largely used in transporting coal from Pittsburg, etc., to New Orleans in barges carrying from 480 to 900 tons. These barges are *pushed* in front of the tow-boat. The Ajax, in this manner, took 22,500 tons from Louisville to New Orleans. The cost of transportation is 80 cents per ton from Pittsburg to New Orleans, 2,000 miles, or $\frac{1}{100}$ of a cent. per ton per mile. Grain and other merchandise are also carried in the same way.

Steam is used regularly on the large canals, such as those connecting the Chesapeake and Delaware bays and the seaboard, the vessels being light-draught propellers with elevated cabins. The enormous traffic of the Erie and others of the long canals is as yet mostly carried in boats towed by horses and managed by companies and individual owners. Steam is, however, being introduced; the tug-boat consort and cable systems each having its advocates. Single steamers are also used to a limited extent, but are generally not considered advantageous, as the size of the hulls is restricted by the locks. The boats to and from the Erie Canal are towed on the Hudson River between New York and Albany, in fleets of 20 to 30 or upwards, by large side-wheel steamers specially adapted for the purpose.

On the lower Hudson are quite a number of propeller lines. The boats are arranged to carry freight on the lower deck, and cabins are provided above for passengers. These steamers tow barges with hulls of somewhat similar construction when greater capacity is required.

The ferryboats on the Eastern navigable rivers are a modification of the steamers. The boats are short and broad, and receive horses, vehicles, and passengers from the shore directly on the ends of the main deck, which is widened for the purpose by extending the guards. When being loaded, each boat is moored, end on, to a bridge with one end carried on a float and the other pivoted to the shore. The boats run either way, and are guided to place by pile buffers lining the slip. Passenger cabins are located at the sides on the guards, and occasionally an upper cabin is added. These steamers are made sufficiently strong and powerful to keep up communication through the ice in the hardest winters. On western rivers the ferryboats are more like the ordinary steamers, and run only one way, as they need to head up against the current and land broadside to floats which are connected by bridges to the landings. Special ferryboats are in use for carrying whole trains of railroad cars, and floats carrying eight to ten freight cars are towed from the termini of the lines to freight depots at different portions of the water fronts of the cities, where the cars are often loaded and unloaded afloat.

* American Engineering as illustrated by the American Society of Civil Engineers at the Paris Exhibition of 1878. Compiled by George S. Morrison, Edward P. North, and John Bogart, Committee, Transactions of the Amer. Soc. of Civil Engineering.

CONSTRUCTION OF FERRYBOAT AND ARRANGEMENT OF FERRY SLIPS AND BRIDGES OF THE ERIE RAILROAD FERRY OF NEW YORK.

By O. CHANUTE, C.E.

The general arrangement of American steam ferries, as conducted in the vicinity of New York, and on many tidal rivers in the United States and Canada, dates back to the very beginning of steam navigation, and was designed by Robert Fulton himself in 1809, or soon after the trial trip of the Clermont to Albany, in 1807, had established the success of his application of the steam engine to navigation.

Almost the first use of this invention to which Fulton turned his attention was the establishment of a steam ferry across the Hudson river, between the city of New York and the Jersey shore. He applied for a ferry lease and license in July, 1809, but a competitor having arisen in the person of Mr. John Stevens, who owned the shore line at Hoboken, and the barge ferry to that point, and who had been engaged with experiments in steam navigation since 1803, some delay resulted in settling their conflicting claims.

Leases were finally executed in March, 1811, to Fulton and his associates, under the name of the Jersey Association, for a steam ferry from the lower part of the city of New York to "Paulus Hook," on the Jersey shore (this being the local name of a projecting point of land near the southern limits of Jersey City), and to John Stevens, for a steam ferry from New York to Hoboken, near the northern limits of Jersey City.

Stevens succeeded in being the first to bring his line into operation, and in the early part of October, 1811, began running the first steam ferryboat which plied in any part of the world.

Fulton started the first boat upon the "Paulus Hook" line in August, 1812, and the second in the following year. He obtained a ferry license across the East River, from Burling Slip in New York, to the Fly Market, in Brooklyn, in 1813; and his general arrangement of ferry has continued in successful use ever since, with but trifling alterations.

The system was so thoroughly worked out in the beginning that Fulton's own account of his design will stand fairly well for a description of the ferries of the present day, and the following letter, written by him to Dr. David Hosack, describing the boat, etc., which he had put into operation in 1812 upon the "Paulus Hook" line, will, doubtless, prove interesting:

ACCOUNT OF THE POWLES HOOK STEAM FERRY BOAT, IN A LETTER TO DR. DAVID HOSACK FROM ROBERT FULTON, ESQ., FELLOW OF THE AMERICAN PHILOSOPHICAL SOCIETY, ETC. (SEE PLATE, p. 3159.)

"SIR: At your request, I have sent you a bird's eye and side view of the Powles Hook steam ferryboat and floating bridge, by which everything enters or is landed from her.

"My reasons for her particular form and arrangement of machinery are as follows:

"1st. She is built of two boats, each 10 feet beam, 80 feet long, and 5 feet deep in the hold, which boats are distant from each other 10 feet, confined with strong transverse beams, knees, and diagonal braces—forming a deck 30 feet wide, 80 feet long. To give her more strength, she is held together by four-inch braces, each two inches square, which pass through her one foot above the water line, and key on strong plates on the inside of each boat. Reflecting on a steam ferryboat for Hudson's River, the waves usually running up or down, I found a great breadth of beam absolutely necessary to prevent the boat rolling in the trough of the sea. This is attained by two boats and one space, giving 30 feet beam.

"2d. By placing the propelling water wheel between the boats, it is guarded from injury by ice or shocks on approaching the wharf or entering the docks, which operation being performed twenty-four times in twelve hours, allows no time for fending off with boathooks.

"To give dispatch and convenience, it is necessary the boat should arrive at the bridge without the possibility of any injury; hence all important parts of the machinery should be carefully guarded, particularly the propelling wheels.

"3d. The whole of the machinery being placed between two boats, on the beams over the open space, leaves 10 feet wide on each side, on the decks of each boat, for carriages, horses, cattle, etc.; the other, having neat benches and covered with an awning, is for passengers. On the latter side there is a passage and stairs to a neat cabin, which is 50 feet long and 5 feet clear from the floor to the beams, and furnished with benches for passengers in rainy or bad weather. In the winter there will be a stove in this cabin, which will add much to the comfort of the passengers while navigating through the ice.

"4th. Although the two boats and space between them give 30 feet beam and proportionate stability, yet they present sharp bows to the water, and have only the resistance in water of one boat of 20 feet beam, which diminution of resistance gives speed in crossing.

"5th. The space from "stem to stern," that is, from *A A* to *B B*, of each boat, is 20 feet wide, which gives ample room at each end for carriages or persons to enter or go out of the boat.

"6th. Both ends being alike, and each having a rudder, she never puts about. At New York the horses and carriages enter at one end of the boat, the horse's head toward Jersey. On arriving they go out at the other end, without changing the line of direction; in like manner when coming from Jersey to New York. Thus the shortest possible and quickest movement of all that is to pass is made to save time and secure convenience. Her rudders, which are placed as at *C C*, are equipollent—the iron shaft which serves as a rudder-post standing in the middle of each, as at *D*, by which construction, the pressure of the water being equal on each side of the center, it can go either end foremost. With yokes and parallel bars, the movement of the rudders are carried to the helms at *E E*, the only position where the helmsman can have a full view of all around the boat, and see how to steer her into dock.

"It was at one time my intention to put a rudder on the bow of each boat, and work them by a connecting bar; but considering that such rudders, while acting as bow, would be injured by ice or destroyed by shocks against a wharf or timbers, and knowing that the greatest current of water is exactly behind the wheel and between the two boats, I placed them as delineated, where they answer every desirable purpose and are guarded from injury. In my first sketches I had made the inside line of each boat straight, that the water might have a free passage from one end to the other; but the disadvantage of such a mode of construction would be, that the whole of the inside lines would act as leeboards, rendering it difficult to put her about or to work her up in the tide. Had this boat been moved by wind, such a form, to prevent leeway, would have been advantageous; but moved by steam, the less water she draws, the easier she moves over it in every direction the better; her bottoms are, therefore, made rounding, with very little dead rise. Another material error which would have arisen from straight insides would be that each bearing but half a boat, the two could not give more breadth of beam or so much buoyancy as one of the present boats; and to give the 30 feet beam it would be necessary to have a vacant space between the two insides of 20 feet, which long and hollow bearing would produce weakness. Such a boat, to carry the same weight, would draw near twice as much water as the present steamboats, and create a resistance in the water equal to the present resistance by breadth of beam.

"7th. *F* represents the floating bridges, of which there is one on each side of the river.

"*G* is a coffer, twenty-four feet long, twelve wide, and four deep, which gives a superficies of two hundred and eighty-eight feet, or nine tons weight to press it in the water one foot, or 1,500 pounds to press it in the water one inch. This great resistance gives stability while carriages or heavy wagons enter the boat. The bridge is thirty feet long, twenty wide, fastened by four strong hinges to the coffer at *H*, and to the wharf at *I*; thus the bridge rests and falls with the tide, and is always exactly even with the end of the boat. When low water there is an easy descent into the boat; at half flood, the boat, bridge, and wharf are on a level; at high water, there is an easy descent from the boat to the wharf. As the weight of the bridge is on one edge of the coffer at *H*, to prevent its sinking on that side and rising on the other, a chain is fastened to the bridge, which passes over the pulley, *J*, with a heavy weight, *K*. Such an application on each side of the bridge pulls it up in the middle, and pushes down the coffer at *L*, added to which, a pine log one foot square is bolted on each side of the coffer, as at *M*, with two transverse logs dovetailed into them, of which the weight and leverage retain the coffer in a horizontal position. The next and last thing to be discovered was how to make the boat arrive at the bridge without the aid of boat hooks, or any pushing or pulling, or loss of time or shock, the latter being the most material to guard against; for this purpose the dock which receives her is one hundred and eighty feet long, seventy wide; the bridge is fastened to the middle of the bulkhead. The boat being only thirty feet wide, and the dock seventy, leaves twenty feet vacant on each of her sides. In these twenty-foot spaces and on the water there are floating stages made of pine logs, which lie parallel to the boat for thirty feet, and then run diagonally to the extreme end of the wharves, so that the boat when coming in hits within the seventy feet, and the stages guide her direct to the bridge. The stages are indicated *N N*. To prevent shocks there are two pieces of timber, each eight inches square, as at *O*, which move on rollers, and run out between the bridge and coffer; the two are connected by a crossbar, *P*, and under the bridge by another crossbar, *Q*. To this latter crossbar, and on each side of the bridge, there are ropes fastened, which ropes pass under pulleys at *S*, descend and fasten to buckets at *T*, which buckets of oak, strongly hooped with iron, are fifteen inches in diameter, six feet long, and when full of water will weigh about one thousand eight hundred pounds.

"When the fenders, *O*, are projected to the position delineated, which is about ten feet from the bridge, the buckets are down in the water, leaving their upper rim about three inches above the surface. *W* is the weight of the buckets, which drives the fenders out of their present position. Each bucket has four holes in the bottom, of an inch diameter, by which the water enters as they descend, and which lets out the water as they rise. In case the resistance should be too great for the boat to come close to the bridge, the water running out of the buckets will diminish it and let the boat arrive at the position required. To prevent shock the whole force must be gradually diminished to annihilation; the resistance to the boat must be little in the commencement and increase until the whole power is destroyed. Fortunately this contrivance produces the desired effect. When the buckets are in the water they are nearly buoyant; but the moment the boat strikes the crossbar, *P*, and it begins to run in, the buckets come gradually out of water, and grow heavier each inch they rise, increasing resistance until the momentum is destroyed and the boat arrives at the bridge without shock, when the passengers, carriages, and horses immediately move out and others enter.

"In the present state of this part of the machinery, to prevent shocks, it is necessary the men should be attentive to stop the engine in time. The most perfect machinery is that which leaves as little as possible to the care of men.

"I have some additions to make which will prevent the possibility of shocks, even in cases where men may mistake or be careless. In a new combination of this kind it is not to be expected that everything should work to the best advantage in a first experiment, or that every requisite should be foreseen. The boat which I am now constructing will have some important improvements, particularly in the power of the engine, to overcome strong ebb tides, from which again other improvements will be made, as in all other new inventions. The present boat crosses the river in a calm in fourteen minutes; her average time is twenty minutes.

"She has had in her at one time eight four-wheeled carriages, twenty-nine horses, and one hundred persons, and could have taken three hundred persons more. From the success of this experiment there is the pleasing prospect that boats of this kind will facilitate the passage of many of our wide rivers and bays, and prove an important benefit to our country.

"I am, sir, respectfully,
"Your most obedient,
"ROBERT FULTON."

The mode in which the boats cross the river causes the chief peculiarities of the system. While, upon the steam ferries in use in other countries, the boats generally land with their sides against the shore, thus compelling a half turn at least with every crossing of the water, in the Fulton, or American system, they ply like shuttles between the shores, and are loaded and unloaded from the ends instead of from the sides. Thus the boats cross the river without turning, and effect a material saving of time, besides adding to the convenience in loading and unloading.

Beyond a general increase in size, but few changes have been made in Fulton's original design. Single hulls were substituted for the arrangement of double boats in 1836, and have been preferred ever since. The docks or slips have been inclosed with spring piles instead of the floating stages, and the ingenious buffer of Fulton has been dispensed with, India rubber springs at the hinge of the floating bridges being substituted, while the boats are slowed upon their entrance into the slips by reversing their paddle wheels.

For ease in loading and unloading, rapidity in crossing, comfort of passengers, and cheapness of charges, this system is believed to be superior to that in use in any other part of the world.

The particular ferry selected for illustration is that of the Erie Railway. This consists of two lines from the terminus at Jersey City; one to the lower portion of the city of New York, a distance of $1\frac{1}{10}$ miles, and the other to the upper portion of that city, a little over two miles. These are served by four ferryboats, which make four trips or crossings per hour upon the lower, and two per hour upon the upper line. Thus they maintain a speed of about four miles per hour, *including the time stopping and starting and that spent in their docks.* This is generally about five minutes on the lower line, and is found amply sufficient to unload and reload 400 or 500 foot passengers, and 10 to 20 carriages.

The Susquehanna is a fair representative of the line. She is of 921 tons burden, with 692 nominal horse power, and is licensed to carry 600 foot passengers and 25 two-horse wagons, or as alternative 20 coaches, or 16 double teams.

Her cabins are lighted with gas and warmed by steam, and provide seats for 266 passengers.

The ferriage charge is three cents per footman upon either line, thus being at an average rate of about two cents per passenger per mile.

The docks or slips into which these ferryboats run are generally about 180 feet long and about 90 feet wide, being curved, as shown on the plans, to correspond to the shape of the boat. They are lined with spring piles, driven into the mud, which yield and spring back when struck by a boat in entering or leaving. The better to enable the latter to glance off on such occasions, their guards are shod with iron, and slushed with some cheap grease.

In some American rivers of greater rise and fall than five feet, this being the mean tides in the vicinity of New York, the approaches have been made upon a series of several floating bridges hinged end to end, and supported at their junction upon pontoons, which ground successively upon submerged piers, so as to present nearly the same inclination of roadway at the several stages of the tide.

MISSISSIPPI RIVER FERRY BOATS.

The general design of the St. Louis ferryboat is that of two hulls with a single bow; the engine is placed in the center, the wheel working between the hulls, and the cabin is overhead. The entire main deck, except the part occupied by the machinery and boilers, is left open, and forms a standing place for teams and animals which may be driven completely around the boat. The boat lands against a float moored to the shore, and teams drive on at the side.

STEAMERS CITY OF NEW YORK AND CITY OF BOSTON.

The steamers City of New York and City of Boston were built in 1860, for the passenger and freight business between the cities of New York and New London (distance 120 miles), connecting at the latter place with railroad lines for the cities of Worcester and Boston, and other points in the interior of New England; one of these steamers leaving either terminus of the route every evening except Sunday.

Their hulls were constructed in the best manner by Samuel Sneden, from specifications of Charles W. Copeland, the superintending engineer for the steamboat company. They are not only timbered and fastened in the best manner, but have in addition very strong hog or truss frames, well secured by iron straps and bolts, also upon the frame of the hull diagonal iron strapping of flat bar iron, fitted and fastened in the manner usual in the construction of sea-going steamers, the upper end of the diagonal straps being riveted to a longitudinal iron bar 6 inches wide, which is run around the entire length of the vessel, just below the deck beams, and the lower ends terminating some distance below the floor heads. These diagonal bars are riveted at every crossing and bolted into every timber.

For the accommodation of passengers, there are 82 private state rooms and 269 berths. The cabins and state rooms are heated by steam, which is supplied by a small boiler provided for that and other purposes, when the main boilers are not under steam.

There is an ample provision of steam and hand pumps, and other fire apparatus, ready to be brought into use in case of necessity.

These steamers are 305 feet in length, 38 feet 8 inches beam, and 12 feet 4 inches hold.

Their engines are condensing engines, and have cylinders 80 inches diameter and 12 feet length of stroke, of the lever beam type, with double or balanced poppet valves, having "Stevens'" cut off motion for working steam expansively. They have also "Sickel's" patent heart motion with counterbalance weight, to enable the engine to be worked with ease and facility by one person.

The boilers are of the return tubular type; the fuel used is anthracite coal, and the combustion is forced, when necessary, by the use of Dempfel's patent fan blowers.

The engines and boilers were constructed by the Novelty Iron Works, from the specification and drawings furnished by Charles W. Copeland. Their easy and quiet operation and economy, as well as the speed of the vessels, have been all that could have been expected, and in these respects are not excelled by any steamers of their class.

Their paddle wheels are 38 feet 8 inches diameter, 9 feet 8 inches length of bucket, and 28 inches width of bucket. The maximum speed of engine $19\frac{1}{2}$ revolutions per minute, the average being about 17.

The average consumption of coal during the first two years of their running was seventeen tons a passage, but owing to their increased weight, by additions and other causes, the average consumption is now about nineteen tons a passage.

These steamers carry full loads of passengers and usually from 250 to 300 tons of freight.

STEAMER MASSACHUSETTS.

The steamer Massachusetts was launched September, 1876, and commenced running May 7th, 1877. She was built at Greenpoint, Long Island, and the launching weight, without machinery or joiner work, was 1,.00 tons. She is 3,500 tons burden, 350 feet long, 80 feet breadth, and 16 feet depth of hold.

Her frames are of white oak, locust, and cedar. Floor timbers of white oak throughout; sided, 9 inches; moulded 18 inches. Spaces between frames filled in solid, up to turn of bilge. Top timbers of locust and cedar; sided 7 inches. Main keelson and sister keelsons, nine in number, of Georgia pine, 13 by 26 inches. In addition, there are two bilge keelsons of same material, 14 inches deep. These keelsons extend entire length of vessel. The engine keelsons are of white oak and Georgia pine; length 60 feet, by 5 feet 3 inches in depth; width, 3 feet. Bilge strakes are ten in number, 9 by 11 inches, of Georgia pine. Ceiling and clamps are 6 inches thick, of Georgia pine. Deck beams of white pine, 8 by 8, to 15 by 18 inches. Deck of white pine, $3\frac{1}{2}$ inches. The frames of hull are diagonally strapped with iron bars, 4 by $\frac{5}{8}$ inches; spaced 4 feet. The planking is of white oak; the bottom $3\frac{1}{2}$ inches, the sides and tops 4 inches. The strings are of Georgia pine, 6 inches thick, three strakes in depth. The masts are five in number, 67

feet high, 18 inches in diameter, connected to each other and to the hull with stays of iron 2 inches in diameter. The truss or "hog" frame is 40 feet high above main deck, extending the entire length of vessel, the timbers composing the same of unusual strength. The iron rods and straps combining the frame with the hull are in proportion with the timber. The guards are protected below with lattice sponsons.

There is a grand saloon or state-room hall, arranged with gallery and second tier of rooms. There are two hundred rooms, each accommodating two persons; there are a number of large rooms. There are two hundred and twenty berths for first-class passengers. There are electric bells in each room connecting with the steward's department. The rooms are carpeted with Wilton, Axminster, and velvet; furnished with black walnut bedsteads, hair mattresses, and are excellent in every appointment. The steamer is lighted throughout (including rooms) by gas, and is heated by steam. The dining room is on the main deck. It is free from all sleeping apartments and the foul air of lower cabins. About three hundred and eighty thousand feet of lumber was used in constructing the joiner work.

The machinery is an engine of the vertical beam type, with a cylinder of 90 inches diameter, and stroke of 14 feet.

The wheels are 39 feet 7 inches diameter.

The engine is fitted with the Sickel's adjustable valve gear and a tubular surface condenser, with Lighthall's patent tube heads and tube packings. The refrigerating water is circulated by means of an independent centrifugal pump, capable of moving 6,000 gallons of water per minute. The same pump is fitted with appliances by means of which the whole capacity could be used in freeing the vessel from water in case of severe leakage.

The boilers are tubular, six in number, of steel. They are circular, 12 feet 8 inches in diameter, and each has three circular furnaces 3 feet 4 inches diameter. The boilers are placed thwartship of the vessel, in the hold, with fire room between, fore and aft. The boilers are connected to two independent steam "drums" or chimneys, each boiler having a separate shut off valve, which admits of their use together or separately. The smoke pipes, two in number, are 8 feet in diameter, placed "fore and aft." In addition to the ordinary steam and hand pumps for extinguishing fire, steam pipes are run to all parts of the vessel, so that by the simple turn of a valve, always under the control of the engineer, a fire can be extinguished before it has fairly started. The engine is capable of making twenty-four revolutions per minute; and when making only twenty per minute she acquires a speed of 19½ miles an hour.

The steamer Rhode Island is similar in style and finish, and has all the improvements of the steamer Massachusetts. She is the fastest steamer leaving New York, and can run twenty-two miles per hour.

Both of these steamers are steered by steam, having separate engines for the purpose.

The cost of these steamers—Massachusetts and Rhode Island—ready for service, was $500,000 each, viz.:

Hull	$120,000
Machinery and boilers	180,000
Joiner work	90,000
Furniture and equipments	110,000

They are manned by a crew of ninety men, viz.:

Deck department	26
Engineers' department	30
Stewards' "	34

The Massachusetts and Rhode Island are owned by the Providence and Stonington Steamship Company, which operates two lines between New York City and New England, which are known as the Providence Line and the Stonington Line.

The route of the Providence Line, which was first established in 1822, is from New York City to Providence, Rhode Island, by water, a distance of 184½ miles; thence by rail to Boston, Massachusetts, a distance of 42 miles.

The Stonington Line, established 1836, is between New York and the East, the boats running to Stonington, Connecticut, a distance of 120 miles

There were carried last season upon the steamers of the Providence Line, from May 7th to October 4th, over 86,000 passengers and 224,250 tons of freight. The Stonington Line steamers carried 56,270 passengers and 327,130 tons of freight.

THE AGAMEMNON.

On September 17 the central citadel ironclad ship Agamemnon was successfully launched from Her Majesty's dockyard at Chatham, in the presence of many thousands of spectators. This is the second ironclad of the type known as "central citadel ships" launched for our navy, the first being the Inflexible, about which controversy raged so fiercely a year or two ago. The Agamemnon is a sister vessel to the Ajax, building at Pembroke. They are in the essential features of their design similar to the Inflexible, but they are smaller, less powerful, and less costly than the latter vessel.

The length of the Agamemnon is 280 ft., as compared with the Inflexible 320 ft. The Agamemnon has 66 ft. beam, the Inflexible 75 ft., and the former has a load draught of water of 23 ft. forward and 24 ft. aft, giving a mean draught of 23 ft. 6 in. against the Inflexible, 24 ft. 6 in. The difference in size will be seen in a still more marked degree by comparing the displacements, the Agamemnon having an estimated load displacement of 8,500 tons, against the Inflexible's 11,500 tons. Like the Inflexible she consists of a central armor-plated citadel extending about 9 ft. 6 in. above the water for about one-third the length of the ship, the remaining two-thirds being unprotected, except by a 3 in. armor deck situated about 6 ft. below the water. The armor on the citadel extends down 6 ft. below the water, and varies in thickness from 18 in. to 11 in., the corresponding thicknesses of the Inflexible being 24 in. and 16 in. This armored citadel incloses the magazines, engines, boilers, and the turning and loading gear for the two turrets which rise above. The turrets are plated with 16-in. armor, and each is to carry a pair of 38-ton muzzle-loading guns of the Woolwich pattern. The turrets are placed some distance out from the middle line of the ship, one on each side, so that the four turret guns can be fought together, either direct ahead or direct astern, and they can also be all four fought on either broadside. It is doubtless an advantage to have the turrets placed *en échelon*, so as to get a powerful bow fire, but it must not be forgotten that we pay for it by sacrificing half the fighting power on one bow and on the opposite quarter, and, what is also of much importance, owing to the fighting power of the ship being unsymmetrical, an enemy will probably be able to count with some certainty upon her movements in action, for he will know the direction in which she will always wish to turn.

Before and abaft the citadel the vessel is built up of light material unarmored, and above the armored deck this space in the region of the water-line is subdivided into water-tight compartments, which are to be filled in with cork to prevent the vessel sinking in the event of the ends being struck below water. The usefulness of this was one of the bones of contention in the Inflexible controversy. Mr. E. J. Reed, together with ourselves and others, contended that the cork stuffing could not be depended upon, and that the armored citadel should be sufficiently large to insure the safety of the ship against capsizing if the unarmored ends in the region of the water-line were riddled and the cork blown out. It was at first contended on behalf of the Admiralty Constructors that this condition was fulfilled in the vessels in question, and afterwards the defense was shifted, and it was argued that the condition was an unnecessary one. The defective stability which we condemned in the design of the Inflexible exists to as great an extent, probably greater, in both the Ajax and Agamemnon, and in this respect we condemn them as strongly as we did the Inflexible, for we are convinced they will prove treacherous in a naval action.

The engines are intended to indicate 6,000 horse power, and the speed of the vessel is estimated at 13 knots. She is fitted with twin screws, and is designed to carry 700 tons of coal, which is equivalent to from five to six days' steaming at full speed. Above the citadel deck there is a flying deck superstructure for working the ship. The loading and working of the guns will be performed by means of hydraulic machinery. The vessel has a ram bow, like all recently-built ironclads, and will be fitted with appliances for ejecting Whitehead's fish torpedoes from the armored sides of the citadel. She will be of the mastless Monitor type, and will consequently have to depend entirely upon her steam power like the Inflexible, Dreadnaught, Thunderer, and Devastation.

In offensive and defensive power she is far below the Inflexible, having four 35-ton guns against the latter's four 80-ton guns, and, as we have shown, having 18-in. armor against 24-in. Compared with the Devastation and Thunderer she appears in a better light, the armor being thicker, 18 in. against 14 in., and the armament being somewhat heavier. Against this, however, the Devastation type of ship has complete armor protection all fore and aft, while the Agamemnon is liable to have her speed destroyed, her trim upset, and stability compromised by common shells, without being once pierced through her armor.

The vessel is built on the longitudinal and bracket plate system, with a double bottom, as is customary in heavy ships of war, and she is well divided into water-tight compartments. Especially is this so in the engine and boiler space, where a marked improvement has been made in this respect of late years in our navy. She will carry a crew of about 350 men, and will be provisioned for about six weeks.

The weight of armor and backing of this vessel approaches 3,000 tons, and the weight of the guns and ammunition slightly exceeds 400 tons.

Some further particulars relating to the arrangement of armor and backing may not be without interest. Like the Inflexible the armor is in two thicknesses, with wood-backing between, in this respect differing from the Devastation and all former ships where a great point was made of keeping the armor in one thickness only, it having been found up to certain thicknesses that the resistance to penetration varied nearly as the square of the thickness, and hence one thick plate was considerably stronger than two plates of the same total thickness. The outer thickness of armor on the citadel will probably be of steel. Behind this comes 11 in. of backing fitted between vertical iron girders 11 in. deep. Behind this again comes the second thickness of armor, and behind this about 7 in. of teak backing fitted between horizontal girders of an equal depth. These are attached to the shell plating of the ship, which is in two thicknesses, each ½ in., through which also the whole of the armor and backing is bolted. Inside of this plating come the deep frames of the ship. The total thickness of wood backing on the citadel is 18 in., the same as that of the thickest armor, but like the armor it varies in thickness at different parts. The 3-in. armored deck is also made up of two thicknesses, one being 2 in. the other 1 in. thick.

It has been pointed out by some of our contemporaries that the Agamemnon was designed three years ago, that it has taken this time to complete her sufficiently for launching, and that the Inflexible, which was designed six years ago, is not yet completed. It is a question worthy of serious consideration whether this time could not be much shortened by greater simplicity of construction without adding to the weight or at all diminishing the strength of the ships.

In the three new ships, the Colossus, Conqueror, and Majestic, just commenced, steel will be largely used for the plating, and will be so far an advance upon the Agamemnon, but when it is said that these ships will, "in all probability, be out of date before they are well finished," the question arises whether it would not be wiser to order fewer ships from one design and to push what are ordered more rapidly toward completion.

In glancing back over the history of our ironclad fleet no one can fail to observe that a great change, for good or evil, has taken place in the very principles of their design during the last few years. Noticing only the broader features, the first important change made from the early long ships of the Minotaur type, completely protected from stem to stern, was the introduction of the central battery and belt of armor at the water-line. This is seen in the Bellerophon and subsequent vessels, as well as in some small wooden converted ships. This change enabled the armor to be thickened, and simultaneously the length of our first-class ironclads was reduced from 400 ft. long to about 300 ft. This became the type of the masted ironclad cruiser, a vessel capable of keeping the sea for months together. The next great type introduced, apart from vessels for coast or harbor defense, or special purposes, was the heavy mastless monitor of the Devastation type, which made up in some degree for the absence of masts and sails by an unusually large supply of coal. By this great change we were enabled to rise at a bound from 8-in. or 9-in. armor protection to 14-in. armor, and from 18-ton to 35-ton guns. Here, also, it will be noticed we return to complete protection.

The next great change was to the citadel type of ship, which, like the Bellerophon and the Devastation types, was undoubtedly projected by Mr. E. J. Reed before he left the Admiralty, although not worked out by him in detail. Foreseeing that the time was approaching when side armor would have to be still further thickened to withstand the growing power of artillery, he proposed to confine it to a central citadel at the middle and broadest part of the ship, which would protect the vital parts, and be sufficiently large to insure the buoyancy and stability of the ship in action, while side armor at the ends of the ship was discarded, and a thick armor deck substituted for it 6 ft. below water.

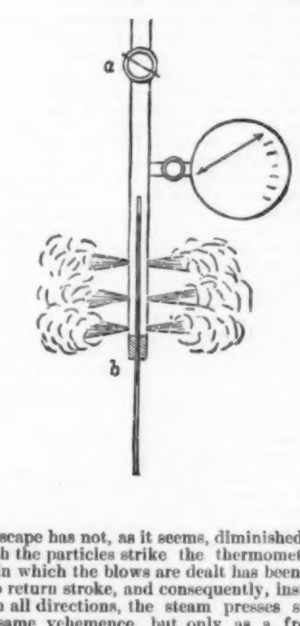
From the nature of this type of ship much greater beam than had hitherto been adopted became an obvious necessity, and accompanying the change, when it took practical form in the Inflexible six years ago, a great stride in the direction of greater beam took place. This type of ship is now embodied in the Inflexible, the Agamemnon, the Ajax, and the more recent heavy armor-clad ships designed for our navy, but with one important exception, which led to the Inflexible controversy, viz., the condition mentioned above, that the central armored citadel should be sufficiently large to insure the ship against capsizing, whatever happened to the unarmored ends, is not fulfilled in these vessels. It could easily be fulfilled in vessels of this type, with little, if any, appreciable sacrifice in other directions, but it is not done. Up to the time of the Inflexible controversy this fact was not known even to the Board of Admiralty, and was stoutly denied. It has since been persevered in with their sanction, although even the Inflexible Committee recommended that this precaution should be adopted in future designs.

We have then this further change to record, viz., that armor protection for the vessel's stability has also now been abandoned, even where for this purpose but a slight enlargement would be required in the citadel that surrounds the engines, boilers, ammunition, and turret machinery. The last step we look upon as a deplorable one, but it has been accepted by the authorities in spite of argument and protest, and we must wait the result, unless in the meantime the questions at issue are put to the test of practical artillery experiments.

The visitors to the launch of the Agamemnon would have had an opportunity of observing a ship building alongside, which is certainly the most remarkable vessel yet designed or built for our navy. We refer to the ironclad torpedo ram Polyphemus, once, we believe, known as the Sartorius Ram, from the general features of the design having been suggested by the late Admiral Sir George Sartorius. In addition to this the ironclad Conqueror has just been commenced, and the Constance, an unarmored cruiser, some distance advanced.—*Engineering.*

THE TEMPERATURE OF ESCAPING STEAM.

A thin metal tube, *a b*, was connected at *a* with a steam boiler; through the end, *b*, a thermometer was fixed in the axis of the tube; numerous holes, of an aggregate area greater than the passage through the cock, *a*, were drilled in the metal surrounding the thermometer; a Bourdon pressure gauge was attached to the tube at right angles, as shown. On opening the cock, *a*, the steam rushed violently through the perforations; the pressure gauge remained at zero, but the thermometer rose to the temperature of steam at 15 lb. pressure. It would appear that the steam, while rushing freely through the tube, has in reality lost its pressure—that is, the tendency to push asunder the sides of its containing vessel, as shown by the gauge remaining stationary; but at the same time the thermometer indicates a temperature corresponding to a considerable pressure. The freedom of the

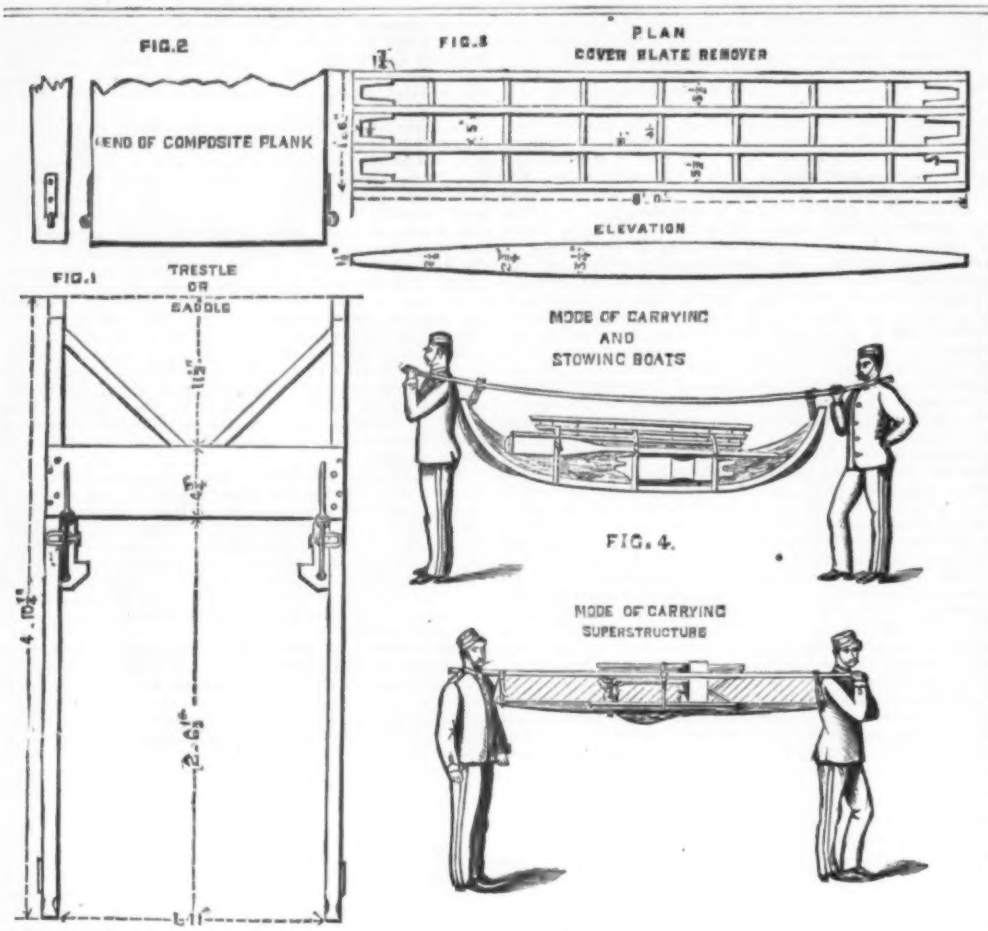


steam to escape has not, as it seems, diminished the velocity with which the particles strike the thermometer; only the direction in which the blows are dealt has been determined; there is no return stroke, and consequently, instead of cubic pressure in all directions, the steam presses still, perhaps with the same vehemence, but only as a free projectile presses, *i. e.*, only upon those bodies which are so placed as to change the velocity or the direction of its flight.

The experiment was devised in connection with an investigation on safety valves, and appears to point out why the steam, rushing out from under an ordinary safety valve, loses so soon the power of lifting the valve; and at the same time it tells us that if we wish the steam to continue to push up the valve, so as to give a maximum opening of escape, we must treat it not as an elastic fluid, but as a stream of projectiles.—*Robert Gill, in the Engineer.*

BERTHON'S COLLAPSIBLE BOAT FOR PONTOON BRIDGE EQUIPMENT.

It has now been decided by the British War Office to adopt Berthon's collapsible boat for use either as a pontoon for light infantry bridges, or as an ordinary boat for use with the wagons of the Royal Engineers' train for an air line telegraph equipment. Patterns of it have therefore been sealed for service, as well as those of the various parts of a superstructure to link the several boats of a pontoon bridge together, when the invention is applied to light infantry purposes. The boat itself is made of canvas, waterproofed with flexible paint, and stretched over longitudinal curved frames of timber. There are two skins of waterproofed canvas, one fixed outside the frames and one inside the frames, so that when the boat is open there is an air space between the two



BERTHON'S COLLAPSIBLE BOAT FOR PONTOON BRIDGE EQUIPMENT.

skins, equal to the depth of the longitudinal frames. Each boat is 9 ft. in length over all, and can be packed when collapsed in a space of 9 ft. by 6 in. by 2 ft. With it are a pair of ash oars, four thole pins, attached to the boat by lanyards, three leather straps to secure it when folded, and a removable thwart or seat. The boat, oars, etc., are strapped together when folded or collapsed, in the manner shown in the drawing, and weigh complete about 105 lb. They are thus tolerably easily carried on a pole by two men for a reasonable distance. (See Fig. 4.)

The superstructure consists of composite planks resting upon trestles or saddles, which stand upright in the boats in a direction from end to end and not athwart them. Each saddle is a small two-legged trestle. The feet of this trestle fit into mortise holes, cut in the bottom gratings of the boat, and are prolonged up above the double transom, so as to form stanchions for a rope rail (Fig. 1). This saddle or trestle is held in its place by guys of copper wire, which hook into staples fixed in the gunwales of the boat, and—on one side—are fixed to a stirrup which rides over the head of the trestle stanchion, resting on a cleat. On the other side the guys are provided with a hide thong, with which they can be made fast to the same stirrup. The composite planks, which are supported at each end by the trestles, and form the roadway or platform of the bridge, are 8 ft. long and 18 in. wide (Figs. 2 and 3), being considerably deeper in the flanges at the middle than at either end. They are constructed as follows: Each plank is made with top and bottom cover plates of Kawrie pine, each 8 ft. by 18 in. by $\frac{3}{8}$ in., fixed down on fir longitudinals or flanges each $\frac{1}{2}$ in. thick, and varying in depth from 3 in. at the center to $1\frac{1}{2}$ in. at each end. The ends of the longitudinals are connected by V-shaped blocking pieces of English elm, and the longitudinals are also connected by pine distance pieces. The planks weigh, complete, 40 lb. each, and will support a weight of 10 cwt. at the center without breaking.

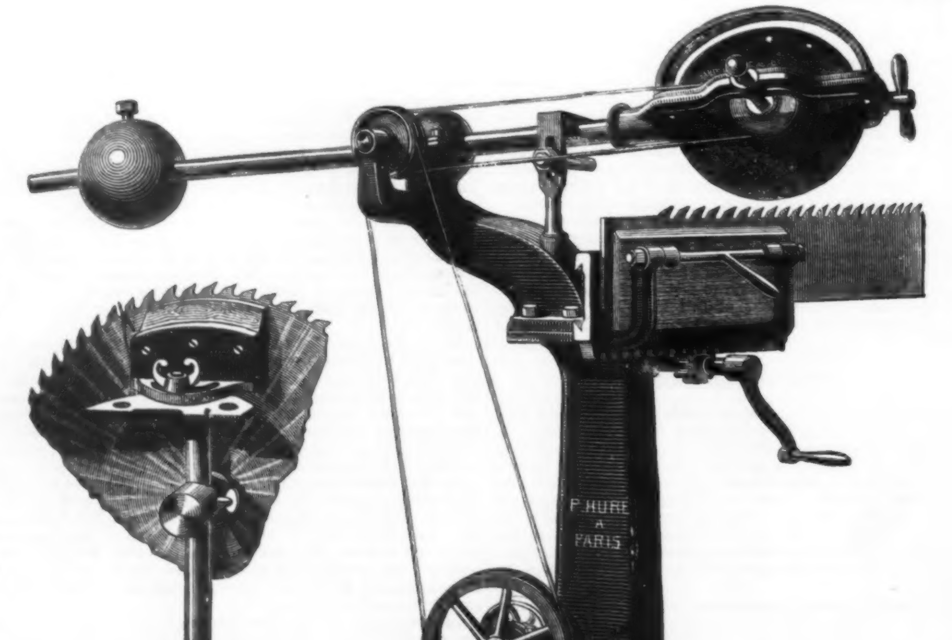
The transoms for landing at the extremities of the bridge are formed of a short piece of elm board, provided with iron loops at each end, through which pickets are driven to hold the transom in its place, and to take the ends of the handrail. The planks are attached to the landing transoms with hasps and staples. The anchors are of galvanized iron, of the common pattern, and weigh 14 lb. each. The cables are of white Italian hemp, each 20 fathoms in length, and $1\frac{1}{2}$ in. in circumference. Twelve boats with oars, etc., and twelve sets of superstructure will be issued to a troop of Royal Engineers when required for telegraph equipment, also for light infantry purposes if thought desirable. This light pontoon equipment is not intended to supersede the ordinary pontoon bridge at present issued as part of the appurtenances of the Royal Engineer train, but only as a valuable adjunct to the equipment of a flying column in cases where heavy transport is not admissible.—*Engineer.*

MACHINE FOR SHARPENING STRAIGHT AND CIRCULAR SAWS.

We give herewith a representation of a new machine for sharpening straight and circular saws, constructed by M. Huré. The arrangements adopted are so clearly indicated in the engraving as to render it useless to describe the machine, which is extremely simple, and recommends itself to the attention of builders in the following points:

The grinding wheel being mounted on a rocking shaft can be inclined in any direction, follow all the profiles of the teeth, and even work around hooked teeth, which is something that cannot be done with other machines. This arrangement also permits of the sharpening of saws with different kinds of teeth without changing the "gummer" for another of different thickness. The pulley which drives the grinding wheel or gummer is mounted on the bearings of the rocking shaft so as avoid all tension of the cord when the wheel is lowered or raised. The main driving pulley may be placed on the standard of the machine, as shown in the engraving, or in the air, according to convenience.

The machine is constructed for sharpening straight or circular saws, although the drawing represents it rigged with a vise for holding a straight saw, and which can be inclined at any angle to give the cut to the teeth. This vise, which is fastened on with two bolts, can be removed with the greatest facility and replaced by the apparatus for sharpening circular saws (shown to the left in the figure) which is fastened on with the same bolts. This also can be inclined at any desired angle, and receive circular blades of any diameter. The machine occupies but little space, and requires no special arrangements for its reception. Its simple and solid construction is the best guarantee that it will work well and last a long time. The price of the machine complete is $70.—*Revue Industrielle.*



MACHINE FOR SHARPENING STRAIGHT AND CIRCULAR SAWS.

STEAM PLOWING ENGINE.

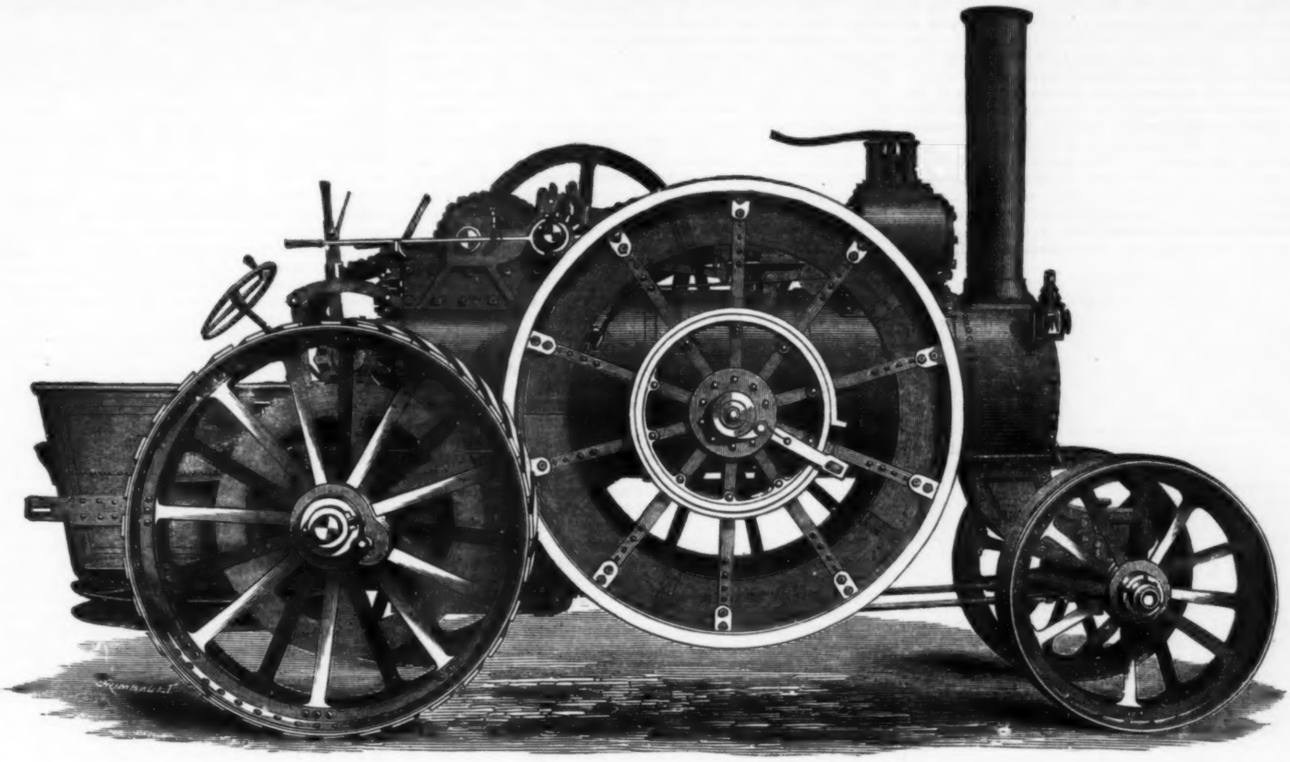
The engine on next page is rated by its makers, Everitt, Adams & Co., of Ryburgh, Norfolk, as a 10-horse, and it is intended for use either as a steam-plowing, traction, or hauling engine. When used for plowing purposes on the system known as the direct or double-engine system, one drum is mounted on the side of the boiler, as shown in our engraving, this drum being driven direct from the crankshaft, and from it the rope is led round a pulley revolving horizontally under the tank, at right angles to the engine, and attached to the plow or cultivator. By this arrangement coiling gear (which in the ordinary way consists of sun and planet motion, cam, die, wrought-iron lever, pulleys, and cage) is dispensed with, as is also the bevel gear and vertical shaft, with its attendant brackets and bearings, so that a lighter and simpler engine is obtained.

The drum is made of wrought-iron, with the gearing bolted on in segments. These segments are so fitted that the power is transmitted direct to the spokes, all strain being taken from the bolts. In the event of a tooth breaking on any one segment it can be readily replaced by means of a new segment, and the entire ring when worn out can be replaced by new segments, making the drum equal to new again. The drum is made 7 ft. in diameter, and 4 in. wide, and the leading pulley is 4 ft. in diameter, and also of wrought iron. By using drums and pulleys of such large diameter, it is maintained that the life of the rope will be considerably lengthened, while the friction of the wearing parts is much reduced.

The engine has a single cylinder well steam-jacketed, and the bearing surfaces throughout the working gear have been made as large as possible, while every facility has been given for thoroughly lubricating all parts. The winding drum is provided with an automatic brake, which puts a slight tension on the rope when paying out, but which revolves freely round the shaft when winding. For the single engine or roundabout system two drums are used, one mounted on either side of the boiler, and the rope is led away by means of leading pulleys on the tank and smokebox to any desirable point.

Should the engine be required for traction, sawing, or thrashing purposes, the drums can be taken off in a few minutes, and their weight dispensed with, or the drums may be left on if preferred. For contractors' use for hauling loads up inclines, etc., the engine is well adapted, as by keeping both drums in gear, and leading the rope off the top of one and the bottom of the other, the descending weight may be made to assist the ascending load.

The front carriage of the engine is partly on the principle of Mr. William Adams' well known bogie, there being an India-rubber pad, which takes the weight, and which yields



IMPROVED TEN HORSE STEAM PLOWING ENGINE.

in any direction to suit the unevenness of the road. Messrs. Everitt, Adams & Co. inform us that they find in practice that this makes a marked difference in running, and that they have run the engine illustrated at the rate of eight miles an hour without any unpleasant motion on the footplate, and this on rough roads.—*Engineering.*

AUSTRALIAN SHEEP.

ONE of the most important articles of exportation of the Australian colonies is wool. Only a few quadrupeds are indigenous in that curious continent. All domestic animals were imported at the time of early settlement by English convicts. In 1789 the idea occurred to Captain McArthur, then commanding the military stationed at Botany Bay, that the sheep was, by its nature and habits, peculiarly adapted to the climate and other conditions existing in Australia. Without hesitation he procured ten ewes and three rams from the Cape of Good Hope, and later, ten ewes were received from Bengal, of a different race. A cross breed was the result; the animals were very rich in wool, and the latter of excellent quality. McArthur's means were, however, limited, and, convinced that the production of wool would ultimately become the principal source of wealth in the colonies, he went to England to obtain aid from the government. The latter did not receive the project with much favor, however, and in parliament McArthur was ridiculed. Lord Camden alone made an exception, and induced the government to present McArthur with a number of males and females selected from the royal flocks at Kew. Thrown thus upon his own resources, McArthur bought up four hundred sheep of the best Saxon blood and left with them for Sydney. Few of the animals died during the voyage; the rest arrived in excellent condition. The descendants of the Cape Bengalese cross breed had meanwhile multiplied, and the race was now again improved by crossing it with the imported animals. McArthur's flocks rapidly increased in number, and in 1823 the first Australian wool, ten bales, was sold in London for £88. Since that time the production has rapidly increased. At present 152,500,000 pounds of wool are annually exported, representing a value of £11,650,000.

There are over thirty millions of sheep in Australia, divided as follows:

New South Wales	8,000,000
Victoria	9,000,000
Tasmania	1,500,000
South Australia	6,000,000
Queensland	6,000,000

These numbers are probably stated too low, as since the last census several years have passed, during which several millions have been added to the stock.

The sheep are a hardy and vigorous race, and their general appearance is well represented in our engraving.

TYPE OF AUSTRALIAN SHEEP.

The quality of Australian wool is well and favorably known all over the world.

PREPARING BEES FOR WINTER.

MR. G. M. DOOLITTLE, Borodino, N. Y., writes as follows in the *American Bee Journal:*

Having our honey all disposed of and our nuclei united, we are ready this month to fix our bees for winter. In some localities, where fall flowers are abundant, it may be well enough to defer getting the bees ready for winter till next month, but with us we rarely ever get any honey after the 10th of September. We consider that the earlier bees are prepared for winter, after honey-gathering is over, the better they will winter. The first thing to be done is to see that all have honey enough for their use during the winter and spring, until flowers open again. and this should not be less than twenty-five pounds, and thirty would be better. If we wish to feed in the spring, twenty will do. To ascertain the amount of honey, lift the frames from the hive and count off the number of pounds, or weigh a hive containing empty combs, and add five pounds to it for pollen and bees; then have your bees all weigh from twenty-five to thirty pounds more than this. There probably is no better way to winter bees than to put them in a good underground cellar. Still, we prefer to winter about one-half in the cellar and one-half out on their summer stands, so as to be sure of being right somewhere, like the farmer who puts in a variety of crops, as all are not likely to fail the same season. Some years bees winter best in cellars, and again out-doors. To this end we built a cellar to hold about one hundred colonies in a bank close by, and have had good success therein. The mercury in it has not been above 46°, nor below 41°, since we built it, during the time the bees were in it.

Bees should be put in the cellar during the first half of November, and when the hives are dry and free from frost, if we wish them to winter well, for we cannot expect them to winter well if they are made damp from any cause whatsoever. Carry them in so as to disturb them as little as possible, and after they are in, leave them as quiet as you can until the pollen is plenty in the spring. Those on summer stands have all the boxes removed and the places used for the side boxes packed with chaff or fine straw. It should be well pressed in so as to fill into all the corners. Fill the caps also and press it in thoroughly, or use chaff cushions if you have them; yet I hardly think them enough; better to pay for the cost in making them. During winter keep the snow away from them so the cap is always in sight. After our experience of last winter, we believe that bees should not remain out of sight in snow for a great length of

time. Give them a chance to fly every time it is warm enough, remembering that a bee can get off melting snow as easily as anything else, providing it is warm enough to raise the mercury to 45° in the shade with it still and the sun shining; otherwise the mercury should mark 50° or above.

As to the safety of wintering we would say that if the bees have a chance to fly once in five or six weeks they will usually winter well; while if they have to contain their fæces for four or five months there will be great mortality throughout the country. This constant eating with no chance to void the fæces for five months in succession, during a cold winter on the summer stands, seems to destroy the vitality of the bees, and makes spring dwindling a necessity. Some feel disposed to call this a disease, or the dysentery, but we can hardly see things in that light.

EAST INDIAN WHEAT.

As regards wheat, India may shortly become one of the chief sources of supply for the United Kingdom. It must be borne in mind that India is one of the largest wheat-producing countries in the world. The production of the United Kingdom amounts to only about 10,000,000 to 13,000,000 quarters per annum. Austria-Hungary, Italy, and Spain each produce about the same quantity. Germany produces from 15,000,000 to 18,000,000 quarters, and the two countries which produce the largest amounts are France and Russia, each producing from 30,000,000 to 35,000,000 quarters per annum. Both are surpassed by the United States, which produced during each of the past two years upwards of 45,000,000 quarters. No complete statistics exist for India, but we know that the Punjab alone produces about as much as the United Kingdom, Oude about 3,500,000 quarters, the Central Provinces about 3,000,000, and Bombay not much less. The production in the Northwest Provinces proper has never been estimated, but must be fully equal to that of the Punjab, and that of Behar is also known to be considerable. Thus the yearly production of the provinces under British rule will amount to from 30,000,000 to 35,000,000 quarters, or to the same quantity as that produced by Russia or Fance. But of the native states in the Punjab, Rajpootana, Malwa, Bundelkund, and Guzerat, be added, in all of which wheat is largely cultivated, it will be found that India must be considered as being, next to the United States, the largest wheat-producing country in the world.

Whilst as regards cotton and some other produce, the soil and climate of India are rather at a disadvantage with those of other competing countries, as regards wheat India is proved to be admirably adapted for the production of the finest qualities of both soft and hard wheat. This is a circumstance of great importance, because the supply of the fine varieties is much more restricted than that of the commoner kinds. In considering the competition in the markets of the world, France, although producing as much as Russia, may be left out of account, as its production, large though it may be, barely suffices for its own consumption. Thus, practically, Russia and the United States are the chief competing countries to be considered. But in both countries the area for production of fine full-grown wheat is comparatively restricted. Spring wheat forms a very large proportion of the Russian supply, as the greater part of the country is too cold for the growth of winter wheat; in the United States, likewise, the climate of Minnesota, Iowa, and the other States on the Canadian border, in which the cultivation of wheat has been recently so rapidly extending, is only adapted for the growth of spring wheat. This wheat, which is mostly red, is not only inferior in quality to a good winter wheat, but it produces also a much lighter crop, not more than 12 to 15 bushels per acre. Thus, however much the cultivation may extend in these parts, it is not likely to affect the supply of the finest varieties, such as are grown in some of the older States or in California.

The true policy for India, therefore, appears to consist in taking advantage of her climatic position, and cultivating for export only the finest varieties, in which the competition of Russia and the far West in America is not likely to be as severe as in the case of the common varieties. Such a policy receives additional recommendation from the fact that the price of the finer varieties is always better kept up, and suffers less in a falling market than that of the common wheat. The higher priced wheat will likewise support better the necessarily high charges of transport and freight.—*Dr. J. Forbes Watson, in the Journal of Applied Science.*

THE PITURI PLANT.

A GOOD deal of interest has lately been attached to a singular plant of Queensland and South Australia, known to the people as the pituri, or, as it has been popularly spelt, pitcheri, pitchoury, or even billgery. This plant is known to botanists as *Duboisia* or *Anthocercis Hopwoodi*, and belongs to the natural order Scrophulariaceæ. The leaves, it is said, are gathered annually during the month of August, when the plant is in blossom. They are dried, first by a process of straining, and then packing them in hemp bags for purposes of trade. To prepare pituri for use it is damped, mixed with ashes, and rolled up into the shape of a cigar, which the people chew, sticking it during the intervals of chewing behind the ear. The effect of the smoking of this novel cigar is very peculiar, rendering the smoker, for the time being, almost insane when indulged in too freely. When smoked in moderation the leaves have a powerful stimulating effect, but the symptoms are somewhat similar to those produced by strong drink when taken to excess. The chewing of a small quantity of the leaves is said to assuage hunger, and a person so using them is enabled to undertake long journeys without fatigue and with little food.

THE NEWER GRAPES.

AT the recent meeting of the American Pomological Society, Rochester, N. Y., the discussion of the merits of the newer sorts of grapes occupied a considerable portion of the session. Moore's Early was pronounced by W. C. Strong, of Boston, the only new sort at that place that he regards as really valuable. The Rogers' Seedlings evidently succeed better in western New York than in Massachusetts, judging from the fine specimens seen on the tables, and hence the superiority of Moore's to any of them at Boston. Moore's is entirely hardy, and was stated by Robert Manning, of Boston, to be two weeks earlier than Hartford. J. W. Manning, of Massachusetts, confirmed R. Manning's statement as to earliness, and added that it is a strong grower and entirely free from mildew, although the Concord often mildews alongside. T. C. Maxwell, of Geneva, regarded Moore's as quite poor in quality, and he did not see what any man wanted with such grapes; it is quite inferior to Worden and other sorts. J. Saul, of Washington, D. C., said Moore's is a fine showy grape, but decidedly inferior in quality, but its early ripening gives it an advantage at the North. Mr. Strong said its great value at Boston consists in its perfect ripening there, where other sorts, doing well in New York, fail. T. S. Hubbard, of Fredonia, N. Y., said the Moore is far inferior to the Concord in quality. G. W. Campbell, of Ohio, has found it this year a week earlier than Concord, and about equal to it in quality. Other seasons might vary this result. Thos. Meehan, of Pennsylvania, thought young vines generally ripen fruit later than old ones. A. C. Younglove said the grapes on young Delaware vines ripen sooner than on older ones, but this is not the case with the Rogers sorts, and that the rule varies with varieties.

S. D. Willard, of Geneva, said that the Worden generally matures two weeks before the Concord, that the berries never drop, and that his vines bear as well or better than the Concord. Mr. Moody, on the contrary, has seen it in several localities, and he regards them identical. W. C. Strong, of Boston, thought it not so good as Concord, although two weeks earlier. [There is no doubt that the Concord has been sometimes sold as Worden, and that in different years and in different soils and localities, the times of ripening will greatly vary, and one sort may be earlier than another this year and later next, and a series of observations is necessary.] G. W. Campbell, of Ohio, has found the Worden to ripen one week before the Concord; it is larger in size and more juicy—in other respects resembles the Concord. T. S. Hubbard, of Fredonia, found the two so much alike, and ripening so nearly at the same time, that he does not need both.

E. Moody, of Lockport, recommended the Niagara as one of the most promising new varieties. He had examined it for several years; it ripens before the Concord; is a very strong grower, holding its leaves long, and the variety is valuable in every respect. J. Crane, of the same place, indorsed this character, and stated that it is a cross between Cassady and Concord. A. C. Younglove, of Hammondsport, spoke highly of its value, and Mr. Hubbard said it is a week earlier than Concord, and a more vigorous grower. The Brighton grape was spoken of highly by several members, being strong, hardy, and healthy in growth, succeeding quite as well as any of Rogers', but one speaker thought the latter a very moderate recommendation, and its growth is not always perfectly healthy.

T. S. Hubbard said the Prentiss has now been fruited ten years, and has continued to gain in character. The vine has proved a good grower, not quite so vigorous as the Concord, but equal to the Diana; it is not affected with leaf blight, with very slight exceptions, but is as free from it as any native except Concord; the cluster is compact, the berries medium in size, greenish white, of excellent quality. It ripens with the Concord. The Lady Washington, one of Mr. Ricketts' seedlings, one-quarter exotic, has fruited only at Newburg. C. A. Green, of Ontario County, has found it a vigorous grower, and others have observed on it a slight degree of mildew. The Pocklington was stated by P. Barry to be a large, handsome grape, rather lacking in quality. A. C. Younglove said its clusters are large and the berries of large size.

CULTIVATION AND DISEASES.

Dr. Hamilton, of Nova Scotia, was here invited to offer some general remarks on grape culture as applicable to that cool region of country. He has grown successfully side by side, by girdling, the Salem, Concord, Isabella, Diana, Delaware, Black Cluster, and Sweetwater. Close pruning is also essential. These sorts do not ripen well in all years. He has found girdled grapes of fine flavor in Nova Scotia, and on being tested along with the same sorts grown in Michigan, the former are pronounced best. He has found a material difference between Worden and Concord. The Black Hamburg in open air, by girdling and close pruning, has produced specimens nearly or quite ripe every year.

The Lady grape was stated by G. W. Campbell, its originator, to be a pure Concord seedling, white, and two weeks earlier than its parent. J. Saul, of Washington, D. C., has found it equally early and of very good quality. A member from Connecticut said it is the best white grape in that State. T. S. Hubbard, of Fredonia, confirmed this statement of its early ripening, and added that the skin is very tender, rendering it liable to crack, and adapted only for home use and near market. Mr. Campbell added that it has large and very strong roots, and the older vines are as vigorous as those of the Concord. D. W. Beadle, of Canada, inquired if there are two distinct varieties known as Champion. Mr. Campbell said there are a southern and a northern variety of this name; and Mr. Hubbard added that only one sort is known at the North, the southern variety never having found its way here. The northern variety, known as Champion and Tallman, has been renamed Beaconsfield, and sold at high prices in Canada to the ignorant.

Isidor Bush, of Missouri, on invitation, gave an account of the best varieties of the grape for that region. The grape growers there have been compelled to reject most of the sorts originating from the species of *Labrusca*, and confine themselves to the indigenous species (*V. riparia*) for the production of successful varieties, for the prevention of rot. Among the best is the Elvira, a grape of great merit, the only defect being too compact a bunch. The Noah is an excellent sort, not so compact, white, transparent. G. W. Campbell has seen the Noah, and found it larger and handsomer than the Elvira, with a purer and better quality, and it does not crack.

Wm. Saunders, of Washington, D. C., read a valuable paper on the cultivation of the grape, containing practical suggestions, and among others on the importance of protecting the trellis against dew and radiation above by a coping or broad board placed lengthwise horizontally. Mr. Bush, of Missouri, read a paper on grape rot. He said rot and mildew are entirely distinct; that we do not now know much more about rot than eighteen years ago; wet and sultry weather accompanies it. He thought that Mr. Saunders' coping, if broad and extensive enough, would be useful, but it would be found impracticable in large vineyards. The Catawba is the first to suffer; the Concord has been recommended as proof against it, but in some places it had been fatally attacked. The disease is a fungus under the epidermis, not reached by sulphur, carbolic acid, or sulphite of lime. Paper bags have been used with some promise of success, but they need farther trial. Vigor of growth in the vine is not proof against it; soil does not affect it, and in proof of this Mr. B said that some vineyards within the past four years have been destroyed, alike on hillsides and in valleys. He looks for some new remedy, but more especially for new varieties from the native species, and he hopes for a return of more favorable seasons. He stated that wet weather has not influenced it, that this year it began early in summer during a great drought, and after the rains came it ceased. But we know very little about it, and he left it open for further investigation.

Mr. M. B. Bateham, of Ohio, exhibited bunches of Iona, Catawba, and other sorts, badly affected and ruined by rot. He said it varies in the time and mode of attack; sometimes while the berries are small, and at others when nearly grown; rarely after the seeds begin to harden. There are 10,000 acres of vineyard in Ohio, one-half of which lie along the lake shore, and the other half in small plantations through the interior of the State. Along the shore and on the islands they are nearly exempt from the dampness of dew, and most of these escaped rot. Thousands of acres of vines inland have been grubbed up on account of the disease. He asked the American Pomological Society for relief. He thought the disease is caused by rapid growth in early summer, and then a check by close, damp, sultry air, which tends to develop the parasitic fungus—its immediate cause. He has known a streak of such weather to carry a streak of rot through two or three counties. He recommended as a remedy, keeping the roots dry and preventing succulent growth. On a naturally dry soil with natural drainage there has been little rot; on low land, even if well underdrained, it has prevailed. The advantage of the coping mentioned by Mr. Saunders, he regarded as owing to the warding off of the dampness of dew and rain.

N. J. Colman, of St. Louis, said his experience conflicts with that of Mr. Bateham. He can always obtain four or five good crops of grapes from young vines, while old ones lose all their fruit. Hence the remedy is in repeated plantings every few years. It cannot be weather. G. W. Campbell said the Delaware does not rot, and he therefore recommended raising seedlings from the Delaware. Mr. Bush said the Delaware is so subject to mildew that it cannot get a chance to rot. Dr. Warder urged the importance of looking to other varieties than those from the Labrusca, as recommended by Mr. Bush. Mr Bateham said the reason old vines are most affected, is because the germs of the fungus gradually take possession as they become older. Mr. Saunders said that by using a self-regulating thermometer, he found the temperature under the coping 8° higher than elsewhere, and the grapes if exposed were chilled and injured. Mr. Strong said that vines kept warm by training over rocks escape. Dr. Hamilton said they rarely have rot or mildew in Nova Scotia. Dr. Warder said that the conclusion reached by cultivators in Ohio in relation to the identity of the two diseases, is that the same fungus causes both, in different stages of growth. But G. W. Campbell did not know how to reconcile this with the fact that the Delaware never rots, but often mildews. Dr. Warder said that in all the discussions on these diseases, they have always come to one uniform conclusion, namely: "We do not know."

THE EXHIBITION AT ROCHESTER.

The western section of the Empire State is pre-eminently noted for its fruits and flowers, and a few of the purely horticultural features of the recent exhibition at Rochester are worthy of especial note. To begin with the fruits, which were so capitally brought to the front—apples and pears were no doubt by far the most important exhibit; but to me, at least, they would have been infinitely more interesting had some little pains been bestowed upon classification. This seems to be utterly neglected, and form, color, quality, and season are almost invariably mixed up in inextricable confusion; nor are the labels attached in the best possible manner, or in the most readable condition. I think the judges would do well to make it a point, wherever two collections approach each other in merit, to award the premium where most attention is given to these very essential features.

Marshall P. Wilder, of Boston, showed a splendidly finished collection of pears, containing 126 varieties; but in fruits of all kinds, Messrs. Ellwanger & Barry fully sustained their well-earned reputation. They showed some 35 varieties of plums; apples and pears in abundance and excellent condition; and grapes in some 6 dozen varieties. Their collection of these latter was singularly fine, embracing many of the showy Rogers' hybrids and others of like character. Among reds the most striking in appearance were Gaertner, Agawam, and Salem. In black grapes, splendid in bunch, berry, and finish, were Concord, Wilder, Merrimack, Barry, Herbert, Rogers' 36, Creveling, and the Brighton—a grape of a deep red rather than black, large in the bunch and berry as a Hamburg, and excellent in flavor. Grapes with the appearance of the Grizzly Frontignan were represented by the Goethe, a beautiful grape in the berry, rather irregular in the bunch, of exquisite flavor for an American grape, but requiring a south wall to bring it to full ripeness and perfection north of Baltimore. The Diana is another good looking and well known grape, of much the same color as the Goethe. White grapes were not so well represented by this firm as by other parties, their best being Rebecca and Martha.

Much attention seems to have been bestowed on the raising of a first-class white grape, and there were three new ones competing for public favor at this show. I shall try to tell you just what I think of them, and I can do so freely, for I know none of the parties interested in them. The Pocklington was the largest grape both in bunch and berry, but it was not fully ripe, and in that state it was decidedly "foxy." A fine grape exhibited for the first time this fall, and named "Niagara," is a very promising grape indeed. It was originated in 1872, and is said to be a cross between Concord and Cassady. Well exposed bunches are almost as beautiful in appearance as the Royal Muscadine; the skin is tough, and it is said to be hardy, and a good bearer, but it is not by any means destitute of the "foxy" flavor so much admired by many. A smaller grape, tougher in the skin, but better perhaps in flavor than either of the preceding, is the Prentiss; it is of the size both in bunch and berry of the average Concord. Mr. Ricketts, of Newburg, had several fine seedlings of the size and appearance of the Rogers' hybrids. Lady Washington is a grape among these of a fine appearance and reputed good qualities. Any one wanting a selection of hardy grapes of splendid appearance cannot be wrong in planting and giving a trial to any or all of the above. They represent the century of progress in American grape culture, and if I were planting to-morrow, I should confine myself to the foregoing list, and perhaps weed out half of them after farther trial in any given locality.—*Country Gentleman.*

CERESIN, a mixture of refined earth-wax and carananba-wax, is frequently employed to the extent of 33 to 50 per cent. to adulterate bees wax. As pure bees-wax is lighter then the spurious article, detection is easy. If the wax does not float in dilute alcohol having a specific gravity of 0·945, it is safe to reject it as spurious.

EXPORT OF AMERICAN FOOD PRODUCTS TO ENGLAND.

THE London *Daily News* publishes the following statistical statement on this subject, supplied by Mr. Victor Drummond, H. B. M. Secretary of Legation at Washington:

WHEAT.

Lowest and average prices of Wheat on board at New York, Philadelphia, Baltimore, and Boston, and landed at Liverpool first half-year 1879. *The dollar is equal to* 5s.

Lowest price per bushel on board at New York, 1 dol.; at Philadelphia, 1 dol. 6 cents to 1 dol. 16 cents; at Baltimore, 1 dol. 6½ cents; at Boston, 1 dol.

Average price per bushel of red winter:—On board at New York, 1 dol. 12 cents; at Philadelphia, 1 dol. 11 cents; at Baltimore, 1 dol. 6½ cents; Boston, 1 dol. 6 cents.

Average price per bushel landed at Liverpool:—From New York, common wheat, 1 dol. 17 cents; red winter, 1 dol. 24 cents; from Philadelphia, red winter, 1 dol. 18 cents; from Baltimore, ditto, 1 dol. 27 cents; from Boston, ditto, 1 dol. 21 cents.

Average freight per bushel:—From New York, 6d.; from Philadelphia, 3¾d., or 7½ cents; from Baltimore, 6¾d., to 7d.; from Boston, 7½d.

The average price of red winter wheat per quarter landed at Liverpool is then as follows:—Landed from New York, 41s. 4d.; landed from Philadelphia, 39s. 8d.; landed from Baltimore, 42s.; landed from Boston, 40s. 4d. We here observe that wheat from Philadelphia is landed in England at a cheaper rate than from the other ports. The low freight from Philadelphia is the principal cause, and this arises from that progressive city reaping a large share of the trade to Europe. From the 29th of July to the 4th of August, over 1¼ million bushels, or more than four times as much as during the same period last year, has been shipped. This steady increase in the grain trade requires a large fleet of ships, chiefly British, which are now flocking to the port of Philadelphia. From information which has reached me, I am led to believe that, under certain conditions, wheat can be delivered at Liverpool from Philadelphia, with a margin for profit, for 35s. a quarter. It is not probable that this will happen, but I mention it as a remote possibility, although it would not be a lasting one.

The total spring wheat acreage sown this year in the United States was four per cent. greater than last year, and the increase will no doubt be as great each successive year, until there are symptoms of no profit in this direction. The yield in the one great wheat State of Minnesota for this year is calculated at 40,000,000 bushels; this is calculating that in two-thirds of its wheat area, 1,900,000 acres, there will be an average yield of 13 bushels per acre; and in the rest of the area, 6 0,000 acres, the yield will be 17 bushels per acre. The cost of wheat per acre in the great wheat-growing States averages 20s. per quarter.

It is a very different thing in the North-Eastern States, where the farmers are handicapped as ours are by the extraordinary low freight charges from the Western States. Again, their farming is carried on partially under the same conditions as our own; they have the advantage, however, over ours, by generally having good-sized orchards, which in a good year bring them in a fair revenue.

THE CATTLE TRADE.

Now, with reference to the cattle trade between England and the United States, I am enabled to furnish some very important information, kindly furnished me by those who are an unbiased and reliable authority.

New York.—The "prime" beef, wholesale price, has ranged between 9 and 10 cents (4½d to 5d.) per lb For the common quality the price has varied between 7 and 9 cents (3½d. to 4½d.) per lb. since the 1st of January last. Beeves shipped "alive" to Great Britain will average to cost about 5 dols. 70 cents per 100 lb. gross weight. The best grades cost more than this, and the fair grades less. The dressed beef "shipped in quarters" costs from 8 to 9 cents (4d. to 4½d.) per lb. on board in New York, but prime live cattle, for which quotations are made, command, on slaughtering, a better price than ordinary refrigerated meat. The average weight at New York of a "prime bullock" is 1,400 lb., and that of a "common bullock" is 1,100 lb. Average freights per head £3 10s. They have been as low as £2 10s. and as high as £4 15s.

Philadelphia.—Prime shipping are held at 5¾ cents (3¼d.) per lb. They weigh from 1,250 to 1,500 lb. A beast of 1,500 lb. is landed at Liverpool for £24 10s. Average freight is the same as New York, £3 10s.

Baltimore.—Freight per head to England averages same as New York and Philadelphia, £3 10s., although it has been as high as £4. Cattle landed in England will cost there from 90 dols. to 110 dols. per head, clear of any charges—£18 15s. to £23. The freight on kine from Baltimore to England averaged £4 5s. per head; it was as low as £3 and as high as £5 15s. during this past season.

Boston.—Cattle here are reckoned at so much per lb. living weight. The average weight of each animal sent over is 1,450 lb. 5½ cents (3¼d.) per lb. is the average price on board. Freight averages the same as the other ports, £3 10s., although it has been as high as £4. Cattle cost, landed in England, on an average £22.

As to the future prospects of the cattle trade between Great Britain and the United States, I think the following points should be known:

If the present restrictions in England on cattle from the United States were removed, and they were allowed to be landed alive, the trade would increase enormously, and give employment for a large number of British steamers now lying idle; in fact more would be built expressly for the trade. Notwithstanding the present restrictions, and the prejudice created by reports of pleuro-pneumonia and other diseases among American cattle, the shipments from the United States have shown a substantial increase this year. One firm alone in New York sent 2,800 head of cattle the last week of July to Great Britain. Dead American meat is sold in London at 6½d. per lb. at a profit, and it is said that even if sold at 5½d. it would give a small profit.

As long as shippers from New York obtain in Liverpool not less than 7d. or 7½d. for their "prime" beef, so long will a remunerative trade be open to them; but they have obtained readily prices ranging between those given above and 9d. per lb., according to the state of the market. While these prices are obtained, the shipments of American cattle will continue in increasing quantities, for with the vast stock-raising lands in the West there is practically no limit to the exportation; and with reference to this I will mention that in 1877 there were 30,500,000 head in the United States, and next year the returns will probably show 35,000,000 head. Last year 86,000 head were landed in the principal ports of the United Kingdom, 67,000 more than in the previous year, mostly from the United States, 30,925 from the port of New York alone to various countries in Europe. It is calculated that England took 24,834, at 92 dols. a head (say, £20 4s.), and Cuba 40,000 head, at 17 dols. each (say, £3 11s.); the wild grass-fed Texans to Cuba, and the shorthorn grades with better feeding to England and Europe—the latter selling for less than five times the price of the former. The weight of the shorthorn grades was about twice that of the Texan. Ten years will, it is stated, bring a remarkable change in the quality and weight of these Texans, and the improvement will possibly be more than enough to supply in quantity the present exports to Europe. Each year probably adds nearly 100 lb. per head to their live weight. Exportation stimulates careful breeding, enhancing the character, quality, and weight of the animal. This improvement in breeding will be equal to an increase of 25 per cent. in number of cattle. Better feeding produces earlier maturity, and, therefore, if 5,000,000 of these are ready for market at two and a half years instead of three years, and 5,000,000 at three years and a half instead of four years, this would give about 16 per cent. more cattle for market each year without increase of the whole number kept.

Oxen are raised in the State of Colorado, and ready for market at a cost of 4 dols. (or 16s. 8d.) per head, and it is claimed that on a large scale it can be done for 3 dols. (or 12s. 6d.) per head. That the United States is destined to supply England with its main supplies of food I have no doubt, for, as one of my informants states, first, it is in the very nature of American enterprise to push a trade which affords a profit, and to resort to all manner of "cheapening" processes and methods to make it more profitable; secondly, the extensions of railroads and their facilities into Nebraska, South Missouri, and Texas, all stimulate breeding and increase and cheapen both cattle and their transport to the coast; thirdly, British shipowners will construct vessels with a special view to the rapid and improved conveyance of animals across the ocean, and, despite the check caused by the pleuro-pneumonia scare, the traffic will increase. Another gentleman writes from New York: The cattle dealers here are prepared to work at an even much smaller profit than the present, which, they admit, is paying handsomely. Even if freight goes up, which is a straw upon which our farmers in England are clinging, I do not think it will help them materially; I imagine that if any brighter look-out arises, it will be from the intense railway speculations going on in the United States, and from the immense sum which must be forthcoming for the renewal of the 80,000 miles of rails already commencing. Will not foreign shareholders require the interest on their money invested when they find large payments will have to be made for renewal of plant? Will not further capital be required on this account? I only mention this, as it is just possible a rise in transport charges may some day occur, if railway directors find the pressure greater than they can bear.

The United States Treasury Department has recently revoked its order of February last, in which the importation of neat cattle from foreign ports was prohibited; they are now subjected to a quarantine of not less than ninety days, under direction of Custom House officers, and at the expense of parties interested in the shipment.

The Pig Trade.—Now let us see how we stand as to our imports of pigs.

From the ports of New York but few pigs have been shipped this year. The price of pork at New York has varied since 1st January from 4 cents to 6½ or 7 cents per lb.; but 5 cents would be a fair average (2½d.). The rate of freight is equal to about 1½ cents per lb., making the average price in Liverpool 6½ cents per lb. (3¼d.). The average weight of pigs sent from this port for the European market is 170 lb. Larger animals are not shipped, being unsuitable for those markets. A pig of 170 lb. landed in Liverpool would cost £2 10s.

From Philadelphia.—Pigs shipped weigh under 200 lb. Their prices range from 4 cents to 4½ cents per lb. (2¼d.). The freight to Liverpool is 10s. a head, and the pig is landed there for 5¼ cents per lb. (or 2⅝d.). A pig of 186 lb. would be then landed for the sum of 10 dols. 50c. (or £2 4s. 9d.).

From Baltimore.—Pigs landed in England cost, freight included, about 8 cents (or 4d.) per lb. A 170 lb. pig from Baltimore would thus cost £2 17s. 8d.

From Boston.—Pigs shipped cost 5½ cents (or 2¾d.) per lb., and freight 10s. a pig. The weight of pigs sent from Boston is given at 200 lb. A 170 lb. pig would cost landed in Liverpool £2 9s. 9d.

Pig exports from the United States during the fiscal year 1878 exceeded all other exports of domestic animal products more than $36,000,000. Thus:

PIG EXPORTS, 1878.

Bacon and hams	$51,750,205
Lard	30,014,023
Pork	4,913,646
Lard oil	994,440
Live hogs	267,259
Total	$87,939,573

ALL OTHER ANIMAL EXPORTS, 1878.

Cattle and cattle products	$49,230,366
Horses	798,723
Mules	501,513
Sheep and their products	874,093
All other and fowls	46,841
Total	$51,453,536

During the ten months of this present year to April 30th last the value of pig exports appears to have fallen off, owing to the small price they have brought. The quantity, on the other hand, was more than 10,000,000 lb. larger. There was an increase in the demand, but the supply has been so large as to depress the market value.

This year the results from experiments made for the extraction of sugar from the Sorghum plant and Indian corn, and from the beet, will be known, and if any one of these is a success in sugar production and good profits, we may see a diminution in the growth of wheat in favor of the more profitable plants. Canada is also making experiments with the Sorghum cane. The statements given above, I have every reason to feel, are correct; if any errors are to be found, they will be so small that they may be forgiven.

VICTOR DRUMMOND,
H. B. M. Secretary of Legation at Washington.

METHODS AND RULES OF CHINA PAINTING.

GENERAL PRELIMINARIES.

THE studio of a painter on porcelain should have a good light. Special establishments for decoration are generally built facing the north, and without reflections from walls or exterior buildings. We advise the ordinary amateur, who is not always at liberty to choose the most suitable situation, to set his table in the best possible light, so that he may have it always from the left, and thus not be hindered by the shadow of the hand at work. Light from the front is fatiguing to the sight on account of the dazzling brightness of the china. Comfort from the first is very important. The most scrupulous cleanliness and absence of dust are urgently recommended in order that the work may be successful. Ladies protect themselves from fluff off their woolen dresses by wearing a calico apron with sleeves. Great care should be taken to avoid damp, particularly that which comes from an open window when it is raining. Damp is unfavorable to the mixing of colors with a palette knife, as the mediums employed do not amalgamate well with the colors, and they remain lumpy beneath the brush; the painting done under these circumstances does not glaze in the firing, which is a serious fault. The temperature should be rather warm than cold, from 16° to 18° centigrade on the average.

REQUISITES.

In the first place it is necessary, to paint comfortably, that the beginner should have a table devoted to the purpose, as much as possible. It should hold all the implements necessary for this kind of work. There must be on the table: a small easel, a color box, a glass palette a china palette with recesses for the colors, a steel palette, knife to take up some colors, a horn or ivory knife for others, a small muller, 3 lead pencils, 3 lithographic crayons, 1 porcupine quill, 1 penknife, 1 scraper, red sable and camel-hair brushes. In the table drawer: some vegetal tracing paper, black, red, and blue transferring paper, gummed paper for sticking, three small drop-bottles, some soft cambric or old cotten rags, and a stick of modeling wax to fix the prick-tracings and transferring paper.

TRACING.

For tracing the drawing, the following directions may be followed:

Direct Outline.—If the pupil can draw well, he will outline his subject lightly on the object he wishes to paint, directly, without tracing, by means of a lithographic chalk. It is cut like charcoal, that is to say, the contrary way to lead pencils, the point resting on the index finger; you must not lean hard, as it is brittle. This chalk being greasy should be rolled up in paper, or placed in an ordinary porte-crayon. It draws on china without any preparation. The false marks are wiped off with a brush slightly wetted with water, or else with a dry rag.

Transferring.—When you want to make a minute and complicated drawing, you are obliged to transfer to avoid getting double lines on the china. Before transferring, prepare your piece of ware as follows: Pour three drops of oil of turpentine on the plaque or white plate intended for decoration. Then take a small pad formed of pieces of rag of fine material soaked with two or three drops of rectified spirits of turpentine. Pass this rag round and round over the entire surface, so as to leave a sort of film, very thin and misty, which you allow to dry by exposing to the open air for a few minutes. The object of this preparation is to render the tracing visible. You may also have recourse to it to get stronger marks from lithographic chalk. It is very easy to trace on a perfectly flat surface. We shall mention several ways.

1st *Method.—Tracing by rubbing.*—After having traced from the engraving or original model to be reproduced the outline of your subject, figure, ornament, or landscape, with one of Faber's HB blacklead drawing pencils, you reverse the tracing over a sheet of white paper, and go over the outline again very carefully with the same pencil; this being done, prepare your piece of china with medium as we have just described. The vegetal tracing paper is then fixed, by means of little lumps of modeling wax, on the exact spot the subject is to occupy; and when that is done you have only to rub all over the outline with an ivory knife, to make the lead that is on the vegetal tracing paper convey itself distinctly on to the previously oiled enamel.

2d *Method.—Tracing with a tracing point.*—Take either black, blue, or carmine transferring paper, according to the tint of the painting that is to be done. The carmine gives all security for the success of the painting; it does not soil it. When the piece of paper has been rubbed with carmine from a soft crayon, after taking great care to remove what is superfluous, it is cut to the size of the subject, or rather to that of the space you are to paint of. To make sure of tracing on the exact spot, you must draw a horizontal line in the middle of your drawing, one also in the middle of the tracing paper, and one as well on the porcelain, with crosses and letters at each end as landmarks: two crosses marked A and B on the horizontal line of the enamel, and + + *a b* on the horizontal line of the tracing paper. The piece is *prepared* with oil of turpentine or spirits of wine. At the end of two or three minutes you place your drawing on the porcelain in accordance with the marks + + *a b*, taking care to place the middle lines one on top of the other, *a* on A, and *b* on B: you fix the vegetal tracing paper by means of small bits of gummed paper, or else with little balls of modeling wax; the sheet of tracing paper being quite firm, you slide beneath it the piece of paper rubbed with carmine, blue, or black lead; you then take a porcupine quill with a fine point, and without leaning too hard you go over all the outline. You must be careful not to press your fingers on the drawing, for it often causes the deposit of powder the same color as your transferring paper, which spoils the result and prevents careful painting. Before finishing all the work, lift up a corner of the overlying papers to see if the tracing does mark. It will be but an affair of habit to trace well, for it is by experiments frequently repeated that one comes to know exactly the amount of strength to be used, so that the transferring paper may mark sufficiently. This paper lasts a long time, and improves as it grows old; you must prevent it from getting creased. For this, each time it has been used, it should be put away into a brown paper cover, wherein the tracing papers are also placed.

3d *Method.—Prick-tracing* consists in pricking the outline with small holes, and in making what is called a "poncif." This can be done by placing the vegetal tracing paper on some cloth folded twice or thrice, with a piece of white paper under the drawing; you prick all the pencil lines with a needle of medium size; when that is done turn the piece of white paper, and with a smooth bit of pumice-stone grind

away the projections caused on the wrong side by the pricks; after which you place it on the china, fixing it with lumps of wax, then rub it over with a pad full of scraped black Conté crayon, or powdered carmine; the outline thus becomes dotted over the surface, and you have only to proceed with the painting.

General Remarks.—For transferring on dark grounds, instead of Conté crayon or blacklead, you may use starch, carmine, or vermilion in powder; substances all clearly perceptible on the dried coating of oil of turpentine. If the tracing has moved, or if, forgetting you had already passed the point over a line, you have made it double, take the handle of one of your brushes which you have cut to a point, and wetting it, you will be able to remove the useless marks by rubbing them gently. It would be better to keep a very thin stick of white wood for the purpose. You will make use of the same means to correct drawings done in lithographic chalk; and this chalk has the advantage that it marks again on the place where the wet piece of wood has passed, whereas on china prepared for blacklead, the pencil marks no longer, the stick having removed the preparation while correcting the lines.

SPIRITS OF WINE.

Experience has proved that paintings progressed under greater advantages when the porcelain and faience had been prepared with a few drops of spirits of wine. The preparation with oil of turpentine, being a fat substance, attracts dust, and thus does mischief to the painting. I protest against methylated spirits, which smell horribly nasty, and do not give such good results.

So little liquid is used, that it is better to have it of the best quality. But you must take great care to cork up the little bottle of spirits of wine hermetically, the contents of which would speedily evaporate.

It is in this same small bottle that the brushes and the dabbers are cleaned after each day's work. To preserve these useful instruments it is indispensable never to leave any color in them, you must take care to wipe them well after this washing, and even to blow a little on them, to make the spirits of wine evaporate, for if any were to remain it would spoil the color and take away the painting already finished. With a few drops of spirits of wine, the most loaded palette can be instantaneously cleaned, and the driest painting can be effaced. For this reason I recommend that the little bottle of spirits of wine be kept always far away from you during your work; if a single drop were to fall on the painting, it would immediately smear and obliterate the work done. Cleaning brushes with spirits of wine has to be done every day. From time to time a more thorough cleaning with soft soap is resorted to; the brushes are steeped in the soap, and are washed the next day only.—*Art Interchange.*

CONFECTIONERY AT HOME.

By CATHERINE OWEN.

As American women excel in making preserves, and attain a proficiency in the art of making delicate cake, only equaled out of America by professional pastry cooks, it is somewhat surprising that they have never turned their artistic hands to the elaboration of anything more *recherche* than molasses candy in the way of confectionery. Yet, to make fine French candies requires no more patience, and is as satisfactory in its results as many of the so-called *distractions* of the present day; it is more cleanly than modeling in clay, and not less so than pottery work. I will, therefore, give some instances in the art, beginning with the simplest form of French candy, called *fondant.*

It is generally supposed that special utensils are necessary to make French candies; and the ordinary directions in a work on confectionery bewilder you with the names of the articles to be used; but perfect results can be obtained with a small enameled or brass saucepan, and a silver spoon and fork.

Fondants.—Take 2 lb. best loaf sugar, put it into the enameled saucepan with just enough water to wet it through, and set it on a clear fire; let it boil ten minutes, and remove away scum that may rise; then take two smooth sticks, dip one in, and if, on touching it with the other, a thread forms, take your candy from the fire quickly. Have a basin of cold water ready and dip a little candy in it from the end of the stick; if, after you have given it time to cool, it does not form a soft ball between thumb and finger, it is not yet boiled enough. Return it to the fire and boil a minute or two longer, trying it frequently. If, however, the candy on being dropped into the water has at all a brittle feeling, it is boiled too much; then add a tablespoon of water, and put it on to boil again till you reach the right point of firmness without brittleness. This may require a little experimenting with, but once the experience is gained, the chief difficulty in making creamy candy is overcome. When your sugar is boiled to the right point, set it aside to cool; if it is quite right when cooling, a thin jelly-like skin will form over it; but it may happen that a sugar coating like thin ice may cover it, which I will term *granulating.* If, however, the candy is only granulated on the top, and the bottom of the saucepan is quite smooth, you can skim off the thin sugar cake, and then take a spoon and stir and beat the candy until it looks creamy and begins to get firm. If boiled enough it will look like lard by the time it is cold. When it is in this state lay it aside; it is ready to use for many purposes. If, however, it is not firm, you must repeat the process; that is to say, boil the sugar up once again, leave it on the fire (without more stirring than is necessary to melt all parts alike) till it is quite clear; then again put to cool, and beat when half cold as before.

Your fondant made, provide yourself with blanched almonds, oil of lemons, ext. vanilla, pistachio nuts, some *prepared* cochineal, a strong infusion of Spanish saffron, a few walnuts taken in halves from the shell, some chocolate, a little fine rum, and curaçoa, maraschino, noyeau—anything, in fact, for flavoring that may be convenient or preferred. To try the effect of your work, now take a piece of the fondant, divide it into as many parts as you have flavors; drop (with *great care,* as too strong a flavor is disagreeable) a little lemon on one piece, a little raspberry sirup (very strong this may be or your candy will be too wet) on another; a drop or two of vanilla on another; rum on another; with the lemon you can also put enough strong decoction of saffron to tint it a pale primrose, and enough cochineal on the raspberry for a pink. Then take each piece and work it like a piece of bread dough till thoroughly mixed; if color or flavor is not satisfactory, add more; here your own taste must decide, many mixtures of flavors being excellent, such as with lemon, lemon and ginger, bitter almonds and lemon; and lemon is always improved by a tiny speck of tartaric acid. Your pieces all worked up, break off little bits, and work into little eggs or balls, or grooved cones. Examine the forms of fine French candies, which are nearly all formed by the hand, and imitate them. This, with the mixture and arrangement of the colors, is the artistic part of confectionery. If you make some of your pink balls as large as a damson, take a blanched almond, press it sideways in it till it looks like a bursting point, just showing a kernel, these are handsome, and may be made in all colors and flavors. You have now made raspberry creams, lemon creams, vanilla creams, and so on.

Panache Fondant.—Take three pieces of your fondant, melt a little chocolate with as little water as possible, by standing it in or over boiling water; when a smooth paste, put it with one piece of fondant; work them together; add a drop or two of vanilla; when the flavor and color suit you lay it aside. With a second piece, pound up some almonds or walnuts very fine; if almonds, add one drop of bitter almond flavor; walnuts require nothing; color the fondant pink, and work nuts and candy together; when well mixed and colored a bright pink lay this aside. The third piece is to remain white and needs only flavor.

Divide the chocolate-colored fondant into two equal parts, also the white; make each part into a ball, then with a small round phial bottle roll each piece on the back of a dish, just as you would a piece of paste, using the finest *powdered* sugar instead of flour to prevent sticking. Roll the candy in the form of a strip 1½ inches wide, ¼ inch thick, and as long as your fondant allows; when you have the two white and two chocolate stripes take the pink; roll it as near the same width and length of the others as you can, but let it be at least *twice as thick.* Then take one piece of chocolate, lay it on a piece of buttered paper; lay next a white strip upon it, fitting as neatly as possible; then pink on that; then another white, and last of all the second chocolate. Now press them gently together, but not so as to put your panache out of shape, and lay aside for an hour in a cool place.

When firm, take a sharp knife, give a sharp, clear cut to the four sides to remove uneven surfaces, and you will have a neat, brick-shaped piece of candy before you. Now with a knife cut it neatly crosswise into little tricolored slabs ½ inch thick; leave them a day to dry and harden, and pack away in rows in paper boxes for use.

Chocolate Creams.—Take a piece of fondant; flavor with vanilla; roll it into little balls the size of marbles. Then take some grated chocolate—it must be the finest French—let it get hot; then take the white of an egg, well beaten, and mix both together. When the egg and chocolate form a smooth, *thick* batter, dip each little ball into it from the end of a fork; if the white shows through, add more chocolate; drop each on a piece of oiled paper, and set aside for 24 hours.

There is a new kind of candy lately introduced by fashionable candy makers of New York, and in the most of the handsome stores. A confectioner stands at work in the window showing the process of dipping the cream; the skillet of hot creamed candy stands beside him, with an under-pan of boiling water to keep it just right. Walnut, almond, and every variety of candy are thus dipped nowadays, and much more delicate than the old-fashioned candies of solid sugar.

Orange and Lemon Creams.—Take an orange, carefully grate off the yellow part of the peel into a plate, then you will have about a tablespoonful of the grated rind; squeeze in this the juice of half the orange and the juice of half a lemon, or a tiny bit of tartaric acid. Then take enough of finely *powdered* sugar to make the orange into a stiff paste; make it into little balls, and put away for some hours to dry. Then take a piece of fondant, put it in a cup, and stand it in boiling water; it will soon soften; move it about till it is like thick cream; then dip each orange ball into it, and drop it off on to oiled paper. If the cream is too thin to cover inside color, let it cool for a minute; warm it again if it gets too thick. Lemon creams are made exactly the same way; walnuts in halves should have the cream candy flavored with vanilla, then be dipped and dropped from the end of a fork in the same way.

Roman Punch Drops.—Make some little balls of the fondant; flavor with lemon and a grain of tartaric acid. Then melt some more fondant as for orange creams; color it pink and flavor it with rum; then dip each of your lemon-flavored balls in it, and drop them from the end of a fork on to oiled paper. This dropped form of candy is very pretty and delicious, and may be made in infinite variety. For instance, mix a little grated cocoanut or chopped almonds with fondant; make it into balls; flavor the outside cream as you choose, and dip them in it. But in making a quantity of candy it is well to have some sorts that require less time, using the drop to ornament the whole.

To this end make fondant as before; take a piece the size of an egg; chop some almonds, work them into it as you would first into a cake; flavor it with vanilla, rose, lemon, or bitter almonds; and have a case made of stiff paper about an inch wide and deep, and as long as your candy will fill. Press it well in, to form it into a neat bar; and when you wish to use it, take it off the paper and cut it into small cubes with a sharp knife; if the blade is wetted with spirits of wine it will cut more neatly.

To make these bars the fondant must be very firm; the best consistency is as hard when cold as winter butter. Should it, by chance, be so hard that it crumbles, or you cannot work it, wet your hand once or twice with any spirits.

In your first efforts at making fondant, you may find, instead of it being as smooth as butter, that it will have a slight sugary texture. If you have the patience, before flavoring or coloring it, add two or three tablespoons of water and boil it up, taking care you have put in enough liquor to thoroughly dissolve the sugar. To ascertain this, take a little in a spoon when boiling; if it is a soft sirup it is right; if gritty, or patches of candy still remain, add a little more water; boil now till it will form a soft ball between the fingers as before directed. To save time, you may pour off a little in a saucer, set it in a cold place, and, when ready, beat it with a spoon. If the result is smooth, and gets firm as it cools, you may conclude that the rest in the saucepan is right; if it is white and creamy but not firm, boil it two or three minutes longer.

Many people do not object to the sugary texture, but I would advise getting the fondant once perfect. The failure to do so once or twice will only teach you the art of sugar-boiling better than a chapter of words, and you will see for yourself how it passes from one degree to another. A pinch of cream tartar put with the sugar when boiling will tend to prevent granulation; but if the least bit too much is added, it will also make it very hard to cream.

In giving these directions I have endeavored to be very clear, remembering my own difficulty in teaching myself from books. For this reason I will emphasize one or two things. Always use the *best* white sugar; be very careful that flavor, color, etc., are highly concentrated, as even a drop too much would make your fondant run. When using chocolate, get the very best French *unsweetened,* your own candy supplies the sugar; and in making dipped candies take care your cream is thick enough to cover well and not to run. If very hot, it may be too thin; then stir a minute till it thickens, keeping it in boiling water all the time it is being used, or it will get hard at once. When you put the fondant into the bowl to bring it to cream, stir it as it warms the whole time, or it will go back to sirup. In using a fork to dip, do not stick it into the articles; drop your ball or nut into the candy, take it out on the fork as if the latter were a spoon; rest it on the edge of the bowl a second to drain it, then neatly drop it on to the oiled paper. The cream candy should not run off on to the oiled paper, leaving inside bare; if it does, beat longer.

Lastly, when I say powdered sugar I mean such as you would use for cake icing, as fine as flour.—*Western Confectioner.*

DIGESTION AND DYSPEPSIA.

A REMARKABLE discussion which has been going on for some time at the medical societies in Paris, has terminated in an important lecture by M. Charles Richet, upon the subject of digestion and the hygiene of the digestive organs. He has, in this instance, brought forward some very useful considerations, which cannot fail to interest our readers, since perfect health and the proper treatment of disease depend so entirely upon our knowledge of the functions which are here discussed.

The first question examined is: What is the influence of the various alimentary substances upon the secretion of the gastric juice? This product of our organism contains two different chemical principles, hydrochloric acid and pepsin, and it is necessary to consider the influence of food upon each of these substances, that is, on the secretion of the acid and on the secretion of pepsin.

As regards the secretion of acid, there is a fact which predominates the whole physiology of the stomach. This fact may be condensed into a few words, and we have proclaimed it when we assert that the gastric juice always tends to preserve a certain state of acidity. In the case of man, this acidity is represented by 0·2 per cent. of hydrochloric acid, but varies, according to circumstances, from 0·1 to 0·3 per cent. of HCl. When alkaline substances are taken, there occurs an increased secretion of the acid; it becomes so abundant in this case, that, in the course of a few hours, not only have the alkaline substances been entirely neutralized, but the gastric juice has recovered its normal degree of acidity.

On the other hand, if acids are taken, a most curious thing occurs. In this case the gastric secretion is dried up, or slackened, for awhile, until, the acids being got rid of, the stomach recovers it normal or primitive acidity. This appears to occur by exosmosis of the ingested acid, whilst the acid secretion remains suspended. Now M. Charles Richet tells us that the consequence of this fact is that acid food, such as children and young girls (especially those who are subject to hysteria) are so fond of, is bad food for the stomach. They impede the gastric secretion, and the normal hydrochloric acid of the stomach is replaced, for the time, by acids much less favorable to digestion, such as tartaric, oxalic, citric, acetic acids, and others, whose action upon albuminous substances is very different from that of hydrochloric acid.

The same remarkable phenomenon occurs when salts of these organic acids form a large portion of the ingesta, such as tartrates, citrates, etc. These salts are all decomposed by the normal acid of the gastric juice, their acids are displaced by the hydrochloric acid, and so become free. Thus the stomach receives again free tartaric or free citric acid, etc., and we have a repetition of the circumstances just alluded to above. Therefore, we must, according to Richet, look upon all acid liquids, such as vinegar, sour fruits, lemon juice, etc., as being unfavorable to gastric digestion, when inquired into from a hygienic point of view.

Another very interesting fact relates to *fermentation* of the food in the stomach. When alimentary substances are withdrawn in a half chymified state from this organ, and their degree of acidity determined, it is found that this acidity has increased, that it is evidently higher than the normal degree, that a certain amount of fermentation has taken place, both in normal health and in pathological cases. This fermentation, the author asserts, is due, at least partially, to those lower organisms termed "ferments," or "organized ferments," which are contained, more or less, in all kinds of food. It is often very useful to digestion, but sometimes not so, and then it gives rise to the acid dyspepsia, with flatulency, which is characterized by acid eructations. Most frequently it is found to be lactic fermentation, but sometimes butyric fermentation occurs, which evolves hydrogen and carbonic acid.

Now, according to the same authority, there are two methods, in appearance contradictory, for causing such exaggerated fermentation to cease, and so to get rid of the dyspeptic symptoms. Both methods, though so opposite in nature, lead to the same result. If lime, or alkaline carbonates, or magnesia, is prescribed, these basic substances saturate the abnormal acid, and when no more excess of acid is present, the mucous membrane of the stomach will be enabled to secrete gastric juice with its normal acid as before. But if instead of administering alkaline or basic substances, mineral acids are prescribed, such as hydrochloric or sulphuric acid, the result will be the same. M. Richet has, at least, convinced himself by experiment, that those fermentations caused by microscopic organized ferments are impeded by the presence of a mineral acid. There may be a considerable amount of truth in this from a theoretical point of view, but, practically, colic is produced by the slightest quantity of mineral acid in the stomach, pointing to the fact that nature never intended it to be there, except in the shape of gastric juice, the chemical properties of which are still in great measure hidden from us.

If M. Ch. Richet has found that a minute dose of hydrochloric acid or of sulphuric acid will overcome what he calls acid dyspepsia, the result of fermentation, he will have caused medical science to have taken a decisive step in a very troublesome and much frequented thoroughfare.

Meanwhile, let us see what he has to tell us on the second question—the influence of the various alimentary substances upon the secretion of pepsin. Since the experiments of Beaumont, Claude Bernard, and Schiff have thrown so much light on this subject, it is well known that all excitations of the stomach do not produce a gastric juice equally favorable to the digestion of albuminous matter. Cellulose, unripe

fruit, salad and spinach, for instance, were found to be very indigestible. They cause an abundant watery flux, in which there is very little pepsin. On the contrary, when milk, meat, or eggs are taken, there is a great secretion of pepsin.

But there exists one important cause of pepsin secretion which might be overlooked by a superficial observer, but should always be present in the mind of the medical man, and this is *appetite*, which must be considered in connection with its opposite, or *disgust* for the particular kind of food offered. At the moment that food is presented to a dog there is an abundant flow of saliva; at the same instant the mucous membrane of the stomach reddens and a secretion of pepsin occurs. Precisely the same thing occurs in man also, and those who are acquainted with the predominating influence of the nerves upon secretion in general, and have present in their minds the intimate dependence of the gastric membrane upon the central nervous system by the intermediary of the pneumogastric nerve and the medulla oblongata, will not be surprised at it. In the same manner vomiting, nausea, and disgust for food are accompanied by a contraction of the vessels of the face and contraction of the muscles of the stomach. The mucous membrane of this organ then turns pale like the face of the individual, and in these conditions the secretion of gastric juices ceases.

No intelligent medical man would prescribe any particular kind of food for a patient until he had carefully informed himself whether this patient possessed an antipathy for such food.

The last point which we shall examine in M. Ch. Richet's lecture concerns the influence of the gastric juice upon the various kinds of food; in other words, the digestibility of the various alimentary substances in daily use. Milk is the most easily digested of all these. After ingestion of a pint of milk scarcely a trace is to be found in the course of an hour It appears probable that milk contains some principle not yet isolated by chemists, the action of which is very similar to that of pepsin, and adds its influence to the latter in the phenomenon of digestion. At the same time M. Richet admits that milk supplies, during this function, a certain amount of lactic acid which co-operates with the acid of the gastric juice. The milk of the cow is, during the function of digestion, precipitated in coarse clots of caseine, whilst that of woman, and mares' and asses' milk, are precipitated in much finer granulations, that are considerably easier to digest. Hence the inapplicability of cow's milk to the nutrition of very young children; hence, also, the advantage of mares' milk or asses' milk for cases of dyspepsia in subjects of delicate constitutions. For the young child the mother's milk can be replaced by nothing; in this all our greatest authorities agree with Dr. Richet. On the other hand, experience has taught us that whatever disease a patient may be suffering from, even in cases of cancer, ulceration, and dyspepsia, a milk diet possesses the greatest advantages.

Without following our author further on the subject of food itself—better known, perhaps, in England than in France—we will conclude by referring to his hygienic precepts as regards digestion and dyspepsia. These are—To live upon a mixed diet, with little wine, and few aliments of an acid or woody (cellulosic) nature. To take moderate repasts. Mankind suffers more from over-feeding than from the contrary. It is a great mistake to imagine that the more food one takes the more mental or bodily work can be done. Over-feeding is the great curse of the age, and equals that of over-drinking by the numerous diseases to which it gives rise. To take our meals with regularity, always at the same hour, and to take care that whilst digestion is proceeding after a meal no food, to interfere with it or check it, is introduced into the stomach. In brief, one digestion should be allowed to terminate completely before another is begun.

With regard to the hygiene of dyspeptics the medical man alone can advise according to the constitution and tastes of his patient; but a milk diet is, in most cases, fraught with the greatest advantages, and is no doubt in strict accordance with physiological laws.

REPLANTING, AND A NEW PROCESS OF INGRAFTING PORCELAIN CROWNS ON NATURAL ROOTS.

By GEORGE W. WELD, D.D.S.

(Read before the First District Dental Society of New York.)

I PURPOSE this evening to direct your attention to a new process of ingrafting porcelain crowns upon the roots of natural teeth. I am well aware of the natural repugnance to receiving, much less adopting, new ideas and processes that demand decided changes in the principles of practice.

As an exponent of a method so intensely radical in operation, and yet so conservative in results, I invite your criticisms, if based on careful observation. Though the subject may be imperfectly presented, the effort will be to consider it from a purely scientific standpoint.

Briefly stated, the process is as follows: the root of a tooth, with or without a partial crown, is first *extracted*, the decayed portion cut squarely off with a corundum wheel, or saw, just at the lingual and libial points of enamel that extend toward the apex of the root, and in all cases, where no absorption of the *alveolus* has taken place, directly under the margin of the gum. A porcelain crown with a tapering screw made of platinum and iridium, which had been securely *baked* in the center perfectly parallel with its length, is then firmly screwed into the pulp-canal of the root, the nerve having first been removed and the canal enlarged by reaming out with an engine-reamer. To facilitate the introduction of the screw, a preparatory thread is cut in the root with a tap. This process establishes a very strong attachment between the natural root and the porcelain crown, and with the additional aid of cement in the canal, it is made perfect. When this operation is completed (which requires from fifteen to twenty minutes) the socket is syringed out with tepid water, and the root with the new crown attached is gently but firmly pressed into its original position. Perfect reattachment ensues in from two to four weeks.

There is seldom any pain in replanting a tooth, and as nitrous oxide gas is usually administered for extraction, the whole operation is almost painless. The inflammation is never as great, and the inconvenience to the patient from soreness of gum is in almost every instance very much less when the root is replanted than when the wound is allowed to heal in the usual manner.

It is obvious that the method just described presupposes, among other essentials of success, the re-establishment of a pericemental connection between the cementum of the root and the pericementum.* The sole object of extraction is to secure by mechanical means a more perfect and less expensive attachment than can be obtained while the root is in the mouth. That ordinary pivoting of teeth fails as a permanent operation can be attributed only to imperfect and insecure attachment. The loss of pivoted roots is the result of the constant motion caused by the imperfect attachment of the crowns.

Your attention is invited to a consideration of the following points in connection with this method of pivoting:

1. The necessity of extractions to secure perfect and inexpensive attachment between crown and root considered in relation to the advantage gained from the use of the screw as a mechanical agent.

2. The function of the pericementum and its reparative power.

3. The permanent success of replanting considered in relation to systemic complications and the liability to future pericementitis.

4. The cementum: its ability to resist caries considered in relation to its vital power and that of the pericementum.

5. Cheapness and beauty of the operation.

The importance of the screw as a mechanical agent in joining two or more things into one is self-evident. There is no necessity, therefore, of elaboration on this point to convince you that its application after extraction renders an attachment between crown and root absolutely perfect, and the operation simple and inexpensive.

The function of the pericementum or fibrous connective tissue of the alveolus is of triple character: first, it retains the tooth in the socket by firmly investing the cementum, or external parts of the root; secondly, it preserves the integrity of the cementum by nourishment; and, thirdly, it serves as a cushion; so that a tooth firmly embedded in the socket, and surrounded by a healthy pericementum that seems apparently immovable, is, nevertheless, susceptible to a slight mechanical change or movement whenever the teeth are closed together or pressure is applied. It has been noticed that a tooth having no antagonizing tooth or opposing obstacle will generally elongate; consequently it would seem that the action of a force directed against the crown and root, such as comes from mastication, is an important requisite in preserving the pericementum in a normal condition. Of the reparative power of the pericementum little that is definite is known. We are informed that it is a highly vascular but "lazy" tissue.

But vascular tissue signifies life, action, and recuperation; lazy tissue just the reverse. It has been remarked by Druitt* that "a precise pathology requires us to separate repair (a process beneficial, gentle, and painless) from inflammation (a process injurious, violent, and painful). True it is that both repair and inflammation have the one feature, exudation, in common; and that exudation induced by inflammation may, after inflammation has ceased, serve the purpose of repair."

Thus while it is important to keep the pericementum of the extracted root free from unnecessary irritation, it is none the less true that the greatest danger to successful and permanent repair comes from another source. The success of replanting in the past serves as no criterion for the present, for the art has not generally been practiced under conditions the most favorable to proper repair.

Teeth have been replanted containing the dead pulp and nerve with a belief that not only would the root reattach itself to the pericementum, but that the nerve and blood-vessels in the canal would reunite with the nerve and blood-vessels severed by extraction.† I think I am justified in saying that the severed nerve and blood-vessels of an extracted root never remain alive, much less reunite. The death of the pulp and nerve invariably follows extraction, and if allowed to remain in the root they become putrescent, degenerating into a putrid mass of such poisonous and irritating properties that even an infinitesimal quantity could hardly fail to retard, if not prevent, the repair of any tissue. Again, to facilitate a thorough filling of the canal and pulp-chamber, an opening has been made from the apex of the root only; but this method necessitates the loss of the most important part of the root—that part composed exclusively of cementum—the portion which, more than any other, possesses a *vital relation* to the pericementum of the utmost importance.

The living corpuscles in the cementum never extend to the cervical portion of the root, but are distributed from the middle of the root to the apical foramen.

To cut off the end of a root and expect permanent repair would seem to be an assumption unsupported by any principles of surgery. The writer has never observed a condition of things which warranted him *in believing that there is ever pericemental* ossification either in replanting‡ or transplanting.§ But that the pericementum is endowed with reparative power of high degree, and the certainty of successful reattachment to the cementum assured beyond all doubt, is a conclusion based on what has been accomplished even under unfavorable conditions. Consider its helpless position; the irritation it constantly receives during convalescence from the act of mastication; and then the results.

A case of repair of a central incisor root with porcelain crown attached now presents itself. The operation was performed in October, 1878, for a young man thirty years of age. From a peculiar position of the adjacent teeth the usual silk ligature was abandoned after the first day. I had but little hopes of saving this tooth, as the patient had no antagonizing molars or bicuspids, so that the front teeth—especially the new one—were compelled to do double duty. A few days after the operation the patient—who, at the time of the operation, was in ill health—started on a trip to Virginia, and while there his only child sickened and died. Tired and sick in body and worried in mind, he returned to New York in an anæmic condition and told me of his grief. But, to my great surprise, he informed me that the tooth which I had replanted less then two months previous was as firm as any tooth in his mouth. He said that he had experienced no inconvenience from it after the third day, and for the first three days nothing worth mentioning. He has now a tooth which for permanency and usefulness, cheapness and beauty, cannot be excelled.

The replacing of a tooth in the socket, so far as the writer has observed, never produces chronic inflammation. On the contrary, whatever inflammation results usually subsides in forty-eight hours, and the process seems to terminate in new formations and the organization of fibrillated tissue.

We come now to the point of considering the permanent success of replanting in relation to systemic complications and the liability of future pericementitis. It is generally admitted, I believe, that the dentine of both crown and root, as well as the enamel, depend chiefly for their vitality on the pulp and the blood-vessels in the canal of the root, and that the cementum is nourished externally from the pericementum. Thus it is that when a tooth becomes pulpless, the dentine, deprived of nourishment, very soon becomes dead in apposition with living cementum, and the pericementum is forced to do double duty. Prof. J. Foster Flagg, in an article published in the *Dental Cosmos* for December, 1878, says that "the work of maintaining this unnatural connection devolves upon the peridentium. It is thus that *double duty* is entailed upon this membrane, and the functional activity which is then developed naturally places it in the same category with all overworked organs or tissues. If the vocal power is overworked, if it is forced to do double duty, laryngitis is the result. . . . If the sight is taxed until it is made to do double duty, sympathetic inflammation is developed, and ophthalmia of varied grade soon establishes a condition which entails the habit of recurrence with every trifling irritation. By the same law of vitality an inevitable and irremediable condition of overwork devolves upon the peridentium of such teeth as have lost their pulps."

The pericementum which surrounds a pulpless tooth is susceptible, however, to irritation and inflammation just in proportion to the amount of dead tissue left in the root and dead dentine in apposition with living cementum, or just in proportion to the degree of overwork this membrane is called upon to perform. And if it is true that pulpless teeth doing normal duty last for a less period of time than those with pulps, the cause is attributable to local rather than systemic complication. The extirpation of nerve and blood-vessels, and a thorough cleansing of the canal from pulp-chamber to apical foramen, is not all that is required to insure the pericementum from future irritation, although it may suffice for a time to prevent inflammation. There is still left in the canal an unnatural connection of dead dentine (too often in a putrid condition) with living cementum,—a mass of basis-substance and dentinal canaliculi (and within each canaliculus a dead dentinal fiber) continuous with living cement-corpuscles. This dead dentine, in the natural order of things, if not already impregnated by a poisonous fluid from a putrescent pulp, is still capable of absorbing fluids, and proving a cause of irritation just in proportion to the susceptibility of the pericementum and the systemic weakness. I wish to urge the position that the nerves and blood-vessels in the canal of a root have but little, if anything, to do with the retention of a normal tooth in the socket; that is the function of the pericementum. Thus it is that when the dead tissues in the root are removed to an extent which prevents any possible injury to the pericementum, the existence of nerves and blood-vessels is no longer a necessity. The retrogressive change, therefore, in the pericementum surrounding such teeth as have lost their pulps, and the premature loss of the teeth, may be attributed to infection from the dead dentine continuous with living cementum.

We come now to consider the cementum; its capability of resisting decay, and its vital relation to the pericementum. After a very careful examination of nearly two thousand carious teeth, I am convinced that the cementum rarely decays. I have in my cabinet over a hundred specimens with crowns partially or completely destroyed, but in all cases the carious action ceased at the line of the cementum. True it is that under the microscope there can be seen a certain degree of decalcification of the cementum, but it is superficial. The great mass of the cement-corpuscles remain unchanged, and the inflammatory elements, so far as I have observed, never cross the line of cement-corpuscles, although from the influence of dentinal decay a few of them become enlarged and inflamed. The truth of the statement that the cementum does not decay to any extent is illustrated by the great number of roots which frequently remain in the socket for many years after the entire dentine of *both crown and root* has been completely destroyed by caries. It would appear from this that the cementum of a tooth possesses an innate power of resisting inflammation and the influence of decay as great if not greater than any tissue of the human body.

Dr. C. W. F. Bödecker, in his recent microscopical researches on "the distribution of living matter in human dentine, cement, and enamel," says of the cementum (see *Dental Cosmos*, December, 1878): "No essential difference is noticeable between the lacunæ and canaliculi of ordinary bone and those of the cementum; in both tissues there exists a great variety as to the general arrangement, the size of the lacunæ, the number and ramifications of their offshoots. . . Each lacuna contains a protoplasmic body with a central nucleus—the cement-corpuscle. The nucleus sometimes is relatively large, and surrounded only by a narrow seam of protoplasm. . . The net-like structure of both the nuclei and the protoplasm is plainly visible on all cement-corpuscles. . . . On the line of the connection with the periosteum the network of the protoplasm is usually very broad, and the fields of the basis-substance show a prevailing globular appearance. . . Between the calcified cementum and the striated connective tissue of the periosteum there often exists a narrow zone, occupied by closely-packed spindle-shaped protoplasmic bodies only. In the periosteum itself there are less numerous partly nucleated protoplasmic bodies, between which the fields of an apparently homogeneous glue-giving basis-substance are seen."

If, then, the cementum has the power to resist decay, if the microscopical examinations of chromic acid specimens admit of no doubt as to the existence of living protoplasmic bodies in the cementum, can there be any reasonable doubt of the VITAL RELATION which it sustains to the pericementum when replaced after extraction? In proportion, therefore, as there exists this vital relation and this living matter in the cementum is the general doctrine of repair established. On the other hand, in the degree of living matter in the dentine deriving its nourishment from the pulp and blood-vessels in the canal, but becoming dead matter when its source of sustenance is removed, is the certainty of its becoming a cause of irritation to the pericementum, and a still greater certainty of double duty being entailed on that membrane.

The vantage-ground which the writer claims, therefore, for this method of replanting considered in relation to permanent repair, is in the increased facility obtained by removing every particle of dead tissue in the canal without destroying the end—the ***most important part of the root;***

* Pericementum is used instead of periosteum, as being more specific. —G. W. W

* Druitt's "System of Modern Surgery," 1867.

† There may be a few exceptions, where in replanting dislocated teeth in children's mouths, the nerve of an extracted root has reunited and afterward been found to be alive. Such cases, however, are exceedingly rare.

‡ The writer is now engaged in a series of experiments by which he hopes to determine the exact physiological conditions of pericemental repair.

§ It is presumed that a tooth which *elongates* in the absence of an occluding tooth is the result of an increased development of successive layers of cells in the pericementum. This may in some measure account for the reported successes in *transplantation*.

thus getting rid also of an *infectious element*, viz., a part of the dead dentine continuous with living cementum, and decreasing very much the chances of future pericemental irritation, or entailing *double duty* on the pericementum. If it be urged that the writer has taken negative grounds in support of permanent repair, it cannot be said that his reasons for believing in re-establishing a pericemental connection are negative. His successes are too numerous, his experience too well fortified with proof, to justify such a conclusion. Out of *thirty-two* cases the writer can record but two failures. The first was a bicuspid with two roots, the bifurcation commencing about midway between the cervical portion and the apex of the root. The second failure was with a first superior bicuspid root with an angle in its center. The masticating force in this case was directed almost entirely against the lingual wall of the socket, which caused inflammation and the loss of the tooth. In the first failure the bifurcation was a contingency for which I was unprepared; and the operation, although a failure, was not a failure in replanting. In the second case it will be observed that the axis of the root did not coincide with the axis of the crown, and it was imperfectly ligatured. I feel confident, with my present experience in replanting, that failure would not again occur under the same conditions.

An eminent dentist of Paris, Magitot, who has recently been experimenting in replanting, has reported to the Academy of Sciences that out of sixty-two cases fifty-eight were successful. From my own experiments, it will be observed that this art, even in its infancy, and necessarily imperfectly practiced, results in only three and one-fifth per cent. loss. As to the permanency of repair, the writer has positive knowledge in one case at least. He is assured by one of his patients, now residing in New York, that she had the misfortune about the year 1838 to receive a severe fall on the face, which resulted in the dislocation and complete separation of the superior central incisors from their sockets. These teeth were replaced by the parent a few minutes after the accident, and in a short time they firmly reattached themselves to the socket. I had occasion to fill one of these teeth about five years ago, and found the pulp completely ossified. The appearance of the teeth was normal. For forty-one years these teeth have remained in her mouth free from all irritation—a living proof of the practicability and permanency of replanting.

This method is advisable on account of its beauty and neatness—the porcelain crowns excelling in appearance any other artificial teeth the writer has ever seen, being made to correspond in size and shape with the natural teeth. This method also commends itself because the operation requires but little time and is not expensive to the patient. The great majority of mankind afflicted with decayed teeth cannot pay from twenty-five to fifty dollars for golden crown or golden pivot teeth, especially if they can obtain something superior at one-fifth of the cost.

It is a lamentable fact that countless roots are extracted and lost each year which, by this method, could be made permanently useful. Let the people who suffer extraction once know that the root of a tooth, after the natural crown is partially or wholly decayed, is valuable to them and can be preserved, and a beautiful crown attached at little expense, and the wearing of artificial plates will, in many cases, be no longer a necessity.—*Dental Cosmos.*

[Continued from SUPPLEMENT No. 192.]

GAS AND GAS MAKING.—III.

By L. P. GRATACAP, Ph.B.

THE PROCESS.—*Continued.*

SULPHUR exists in coal gas in the form of sulphureted hydrogen, sulpho-hydrate of ammonia, sulphide of ammonia, sulphocyanide of ammonia, sulphurous acid, oxysulphide and bisulphide of carbon, along with other forms not determinable, of an obscure organization and to some extent hypothetical. These impurities are taken out in the purifiers, which are large iron boxes filled with trays on which the purifying material is laid; they communicate with each other, and are so adjusted that when any one of them is completely "fouled" it can be thrown out and recharged.

Lime is better fitted to remove the sulphur impurities than any other body; it seizes the sulphides, the sulphureted hydrogen, the sulphurous acid, and attacks, partly by mechanical and partly by a chemical action, the other sulphur compounds. It withdraws the sulphur in the form of sulphides, which may become complex multiplied sulphides of lime by prolonged exposure to the impure gas, after the simple sulphide has been formed. When the formation of the sulphide of lime has been completed, whether as a mono or a bisulphide, which may be considered as produced by the sulphureted hydrogen which predominates over the other sulphur impurities, these latter are then attacked and fastened upon the original initiative sulphide, but are less securely retained, and become detached by heat or the action in presence of moisture of the carbonic anhydride. The bisulphide of carbon, a malignant vapor, is imperfectly arrested by lime, though a crystallizable salt is to some extent made by their union, and the lime sulphides assist materially in its removal. Heat changes the properties of lime as regards its power to take up sulphureted hydrogen, and over heated lime, viz., between 110° F. and 700° F., a current of that gas may be sent, scarcely appreciably diminished in volume. The bisulphide of carbon is itself when passing through heated lime decomposed, and other sulphureted compounds formed more readily attracted by the cold reagent. Bisulphide of carbon is partially removed in condensation, and the tar and hydrocarbons precipitated in that stage of the manufacture retain it. The lime is used as a hydrate, and must contain more water than will form a simple hydrate before it will absorb sulphureted hydrogen with energy. It should also be subdivided as perfectly as possible, for where used in a solid form, only the superficies of the lumps or grains are affected, and even under the best disposition the action is sensibly irregular.

Two methods are adopted in the use of lime for purification, though on sanitary grounds one has become obsolete and the other partially supplanted. The *wet lime* process consists in the use of hydrate or milk of lime, through which the impure gas bubbled. Thus applied the sulphides are rapidly formed, the movement of the liquor bringing new surfaces of contact to bear, and its liquid form adapting it to form a solvent for ammonia salts, and even to prolong the contact between the sulphur compounds and the lime. The gas stream should be finely divided, else it would carry through this lime bath a percentage of its impurities untouched, as the large bubbles, washed only on their outer surfaces, would retain them, and though compression in the heavy liquid tends to flatten the bubbles and so extend the surface of contact, it but very slightly counteracts the evil of admitting the gas to the purifiers through large apertures. The liquid form of lime obviates to an extent the objectionable feature of heating experienced at times in the purifiers, but under the same form it effects a reduction of the illuminants, more especially heavy hydrocarbons.

This process has been abandoned; the pressure of indignant remonstrances from citizens and health boards has compelled its surrender. The liquor, saturated with vile and poisonous bodies, upon exposure to air quickly evolved the most outrageous odors. People of delicate constitutions sickened from apprehension, simply when the carts carrying this loathsome refuse were announced in the streets near them, and so vindictive and excited did public opinion become, that the famous "blue billy," as the fouled lime was called, was incontinently abandoned after subterfuge, ingenuity, and misrepresentation had successively attempted to prolong its life.

The *dry lime* process succeeded, and it was hoped from the easier handling of the material that many mechanical difficulties would be obviated, and the practical effectiveness be as great. This expectation was gratified; the moist hydrate answers admirably for the extraction of the sulphur compounds, admits of easier transportation and of more rapid preparation, and though probably accompanied by greater waste, owing to the agglomeration of the particles together, and, in consequence, their partial escape from exposure to the impure gas, yet it has largely, if not entirely, displaced the wet lime process. But the sanitary discomforts though abated were by no means abolished, and since its efficiency was greatly improved by increasing the degree of wetness, these, in many instances, were almost the same. It was continually assailed, and from this warfare two things resulted. First, the regeneration of the lime, by permitting its foul gases to escape into a washer and thence into the air, comparatively or entirely harmless; and second, a more valuable modification of the process, by using a different preparation, which had before attracted attention, but which now received the greatest impetus from its avoidance of the "sulphur nuisance."

The Lanning Mixture, which finally was proposed as a substitute for the lime, is a preparation of the hydrated sesquioxide of iron with lime and sawdust, and is formed from copperas—the proto-sulphate of iron—sawdust, and slaked lime.

Chemical action ensues upon its oxidation in a current of air, and an interchange of acids and bases results, the sulphate of iron is decomposed, its acid seeking the lime, which becomes a sulphate of lime, while it is converted ultimately to finely divided sesquioxide. The sawdust assists in giving porosity to the mass, and separates the particles of lime and iron. The iron becomes a sulphide, and any excess of hydrate of lime a carbonate, while ammonia compounds are arrested by both, and especially in the lime sulphate, and also in the pores of the moist sawdust. Once used it admits of revivification by the introduction of air, the sulphides of iron become renewed as sesquioxides, and the sulphur deposited throughout the bulk as free sulphur. The chain of reactions with Lanning's mixture are as follows:

(1) $3FeSO_4+3CaH_2O_2=3Fe(H_2O_2)+3CaSO_4$

Upon oxidation—

(2) $4Fe(H_2O_2)+O=Fe_2O_3+Fe_2(H_2O_2)_3$

or—

(3) $4Fe(H_2O_2)+2O=2O(Fe_2)(H_2O_2)_3$

In the purifiers—

(4) $Fe_2(H_2O_2)_3+3H_2S=2FeS+S+6H_2O$

or—

(5) $2O(Fe_2)(H_2O_2)_3+6H_2S=2FeS+10H_2O+4S$

Upon revivification—

(6) $2FeS+S+6H_2O+O=Fe_2(H_2O_2)_3+3S+3H_2O$

or—

(7) $2FeS+10H_2O+4S+6O=2O(Fe_2)(H_2O_2)_3+6S+6H_2O$

The regenerated material admits of being used over and over again until the sulphur has so far accumulated as to deaden the reagents and destroy the mixture's vivacity and power. It is still, however, useful, and may be used in the manufacture of sulphuric acid, as much as 40 to 60 per cent of available sulphur being often obtained in the heaps. When removed it does not contaminate the air by the generation of sulphur gases.

The Lanning process in a simpler form is known as *Hill's iron ore* process, which adopts the same principle, using the hydrated sesquioxide of iron, which with charcoal powder, coke siftings, and moisture, is found to form a very efficient purifier.

These iron ore methods are reasonably cheap, costing less than the lime process, but though exercising a very striking affinity for ammonia they cannot be considered as perfect in their action as the latter. They involve, of course, the supplementary use of lime for the removal of the carbonic anhydride. The oxide of iron is really incapable of taking up other sulphur compounds than the sulphureted hydrogen in itself, and these are only arrested upon the formation after revivification, of free sulphur, which exerts an affinity upon these bodies to a slight though variable degree. Bisulphide of carbon is left in the gas, and nearly all the other compounds of sulphur, and, indeed, owing to the inefficient action of the iron oxide purifiers, did the serious examination of the sulphur nuisance begin.

In addition to these processes it has been repeatedly suggested that the ammonia salts in the ammoniacal liquors could be used in a caustic form for neutralizing and removing sulphureted hydrogen and carbonic acid. Thus Evans and Sugg suggested introducing a stream of ammonia into the hydraulic main at a temperature of 200°F., hoping to unite the alkali with the sulphur and with the carbonic anhydride. The sulphide of ammonia would be formed, but it is very doubtful whether the carbonate would. Von Anaglio arranged a scheme for passing the gas through pipes filled with platinum rolls or thin laminæ of that metal, whereby the bisulphide of carbon was decomposed and the sulphureted hydrogen set free and afterwards taken up by lime. This was to eliminate that poisonous gas.

The lime methods in use have two ends in view, viz., the desulphurization of the gas and also decarbonating it, and these two actions interfere, so that the certainty and extent of the lime purification is greatly diminished. Here we open one of the most interesting chapters in the history of the chemistry of gas lighting, and one which records one of its most striking advances. Theoretically adequate to liberate the gas of its sulphur compounds, yet the effect of the lime purifiers was notoriously imperfect. Sulphur existed in large quantities in the London gas, and rendered the products of combustion in the flame so offensive, from the admixture of sulphurous fumes, that its use was dispensed with in the best houses; and to avoid the damage done to fabrics, books, and ornaments, candles were substituted. Every exertion was made to mitigate the evil, but in spite of all the chemists did, the trouble obstinately refused relief. In 1860 complaint had become vociferous. Parliament was compelled to notice it, and the London gas act of that year enacted that unless the gas companies reduced their amount of sulphur to under 20 grains per 100 cubic feet, a heavy penalty should be imposed for every offense. It was soon found easier to fix a limit than to conform to it, and we may judge of the practical inability of the companies to answer the requirements of the law, when we find from Dr. Letheby's Reports to the city of London that for 100 testings of their gas, the Central Company's gas contained an excess of sulphur 59 times; the City Company's, 34 times; and the Chartered Company's, 43 times, or, to quote Patterson's words, "in other words, if the testings had been made daily (as is the case now) the Chartered Company, merely for one of its works, would have been liable to penalty 157 times in each year; the City Company, 124 times; and the Central Company, 217 times."

In 1868 the penalty of £50 (about $250) a day was inflicted for an excess, and at the same time the Board of Gas Referees were instructed to carefully examine and report upon the occurrence and remedy of this evil.

In the first place the preposterous fact was revealed that the gas of many of the companies, upon passing through the purifiers, contained more sulphur than that at the inlet. From an examination of the gas before and after leaving the scrubbers, the following details were obtained:

The sulphur is given in grains.

Gas Works.	Average.	Sulphur at Inlet.	Sulphur at Outlet.
Great Central Co.	29 Testings.	23·55	28·63
Imperial Co.	4 "	24·7	24·8
City of London Co.	3 "	22·86	25·41
Chartered Co.	11 "	24·63	26·07

Similarly the sulphur tested at the inlet and outlet of the purifiers "at one of the largest gas works in London" showed the same anomalous increase:

Sulphur at Inlet.	Sulphur at outlet of Oxide of Iron Purifiers.	Sulphur at outlet of Lime Purifiers.
21·13 grs.	29·13 grs.	28·46 grs.

After the most elaborate and costly furnishment, with something like twice the area of purification possessed by any other company, and after the reiterated promises of its engineers to settle the sulphur question for ever, the Bekton Gas Light Company produced a gas fouler in this particular than that of any other company in London, containing 55 grs. per 100 cubic feet of the impurity. Mr. Patterson, at that time one of the Board of Gas referees, undertook a systematic study of these perplexing results, and finally evolved a theory which sufficiently accounts for these contradictions in practice, and suggests as well the means and methods by which the sulphur grievance could be alleviated.

Without following the details of the successive steps which lead Mr. Patterson to his final conclusions, we will simply arrange them in their natural sequence.

1st, Mr. Patterson detected that the oxide of iron did not appreciably affect the compounds of sulphur other than sulphureted hydrogen. 2d, that when such other compounds were removed, it was by the action of the free sulphur in the heap. 3d, that the impure gas will readily form sulphides with the alkalies, as ammonia and soda, the latter removing almost 50 per cent. of the sulphur present. 4th, *that the carbonic acid in the gas expelled sulphur from its union with lime, and thus actually added to the gas more sulphur than it held upon admission to the purifiers.* "Each day thereafter the purifying material diminished in power until it became wholly inert, and then gave off the sulphur which it had previously absorbed. This was solely owing to the carbonic acid in the gas, which desulphureted the lime, as also the soda solution, and converted them into carbonates—the sulphur *in all forms* (*i. e.*, both sulphureted hydrogen and bisulphide of carbon) being expelled from the lime and from the soda solution, and driven forward with the gas" (Patterson on Gas Purification). 5th, that though the gas contains far more carbonic acid than sulphureted hydrogen, yet since alkalies had so much greater affinity for the former than for the latter, the carbonic acid could be entirely abstracted without diminishing the percentage of sulphureted hydrogen.

From all these conclusions the outlines of a satisfactory process for sulphur purification were readily deduced, viz.: first remove the carbonic acid, then form sulphides by the union of alkalies with the sulphureted hydrogen, and then permit the gas to pass through the sulphureted alkalies, by which means the sulphur compounds become attached to the alkaline sulphides.

The above principles indicated as well the steps and character of the process. Decarbonate the gas in the first two purifiers, the second being substituted for the first when the gas issuing from the second shows carbonic acid, the first being then recharged.

Pass the gas still laden with its sulphur impurities into lime boxes, where these are arrested in the following order: the sulphureted hydrogen first forms sulphides, and these again remove and fasten the sulphur compounds. When the first lime box becomes thoroughly saturated with sulphur, it is removed and takes the place of the second, it becoming No. 1, to be in turn used as the second box again, for the arrest of sulphur compounds when the second box is freshly charged.

Of course this order applies to the use of soda solutions where scrubbers are substituted for purifiers, and also to gas liquor used in a similar manner. Combinations of lime, iron oxide, soda and gas liquor may be used, the sequence involved being constantly the same, removal of carbonic acid, formation of sulphides by sulphureted hydrogen, and the elimination of sulphur compounds by the sulphides thus formed. If soda solutions are employed, the first liquor on becoming thoroughly carbonated can be renewed by the use of caustic lime, and the sulphides can be revivified by exposing them to carbonic acid, which expels the sulphur as sulphureted hydrogen, to be made commercially salable by its arrest in oxide of iron.

In conclusion, as a commentary upon the nature and importance of Patterson's theory, his own words may prove the most fitting: "By my process of purification, alkalies, whether lime, ammonia, or soda, can now be employed in such a manner as to give adequate and constantly reliable results—these substances being employed alike to eliminate the carbonic acid and to be converted by an economical pro-

cess into alkaline sulphides in any required number of vessels, and thereafter maintained in that condition."

Another method of purification has been lately recommended, and the writer has seen some experiments made with it with apparently good results, so far as the mere fact of purification goes. This is the use of animal charcoal, a refuse from sugar refining, or in place of it, or with it, coke and coal dust. The porous mass entraps the gas and brings within its minute meshes the sulphureted hydrogen, ammonia and carbonic acid, which partially unite in this compulsory contact and are also mechanically retained. This material really exerts a very remarkable influence upon the gas, and also materially diminishes its illuminants, at least at first, so as to be inconvenient from the very excess of its benefits.

With the gas purified, the theory of gas making in its chemical and abstract form ends, and the succeeding steps are mechanical, involving questions of apparatus and application which have been purposely excluded in this brief sketch. The station meters record the yield of gas secured by the engineer from his charges; the gasometers store the product for distribution, and the street mains and services effect that distribution throughout a company's district. The scientific and practical questions connected with the use of gas are best considered under the discussion of *the product* as a sequel to these short papers on the *material* and the *process* adopted to obtain it. In such a connection will more closely be considered the impurities of gas, and the constitutional changes effected in its various stages of manufacture.

BLAST FURNACE SLAG—ITS NEW USES.

SCATTERED throughout the iron-making districts of Great Britain are many million tons of scoria, or refuse from the blast furnaces, which is technically known as slag. This slag goes on accumulating at the rate of nearly 8,000,000 of tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to iron-masters, demanding the purchase of large tracts of land whereon to deposit it, the investment being, of course, wholly unremunerative. There are one or two exceptions to this rule, as at the Barrow Hæmatite Iron Works, where the slag is tipped into the sea and serves to form land for the works, and at Middlesbrough, where some of the iron works supply slag for the construction of the breakwater and training walls in the River Tees. The quantity thus utilized, however, on the Tees, is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district. In some cases where the iron works are conveniently situated, the slag is carried out by barges and tipped on to banks at high water to form training walls or for reclaiming land, being thus got rid of; but, as a rule, the labor and capital expended upon this unproductive substance tell heavily upon profits. No wonder, then, that from the first persistent efforts have been made either to utilize it or to get rid of it altogether. In early times slag was broken up by hand and used for road-making, and it so continues to be used where it can be had without a heavy cost for transport; but there is only a limited demand for it for this purpose.

On the continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilize slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building. Some of these schemes have proved successful within certain limits; but the peculiar nature of the slag has more generally led to failure, owing either to the difficulty of dealing with it or the attendant expenses. Among the most prominent living scientific investigators of the question was Mr. Bessemer, and about fifteen years since Mr. John Gjers devised a method of granulating slag, the sand produced being used in place of silicious sand on the pig beds. The practice, however, was discontinued after a time for technical reasons. Several other practical men have taken an active part in endeavoring to solve the slag difficulty, among them being Mr. D. Joy, Mr. T. Bell, Mr. Lurrman, and Mr. Homer.

Some time since Mr. Charles Wood, of Middlesbrough-on-Tees, directed his attention to the utilization of this unproductive material, and after about five years of careful study, experiment, and practical research, he has succeeded in effecting the conversion of blast furnace slag into various forms, and applying it to several industrial purposes upon a practical and commercial scale. At the time when he started upon his investigations there was no instance of slag being manufactured into a commercial commodity in this country, its only known application being that of road making.

NEW MANUFACTURES OF SLAG.

Mr. Wood, however, has succeeded in utilizing it for the manufacture of building bricks, concrete, cement, mortar, and slag wool. The various processes of conversion and manufacture are carried on under Mr. Wood's management at the Cleveland Slag Works at Middlesbrough, which, together with the adjoining Tees Iron Works, belong to Messrs. Gilkes, Wilson, Pease & Company, of which latter works Mr. Wood is also the manager, and whence the slag is obtained.

SLAG SHINGLE.

In following the highly interesting processes of conversion consecutively, we must first take our readers to the iron works, where the slag is run from the blast furnaces into two different machines, which produces a coarse kind of shingle, and the other a fine sand. For making shingle the liquid slag is run direct from the blast furnaces on to a circular, horizontal, rotative table, composed of thick slabs of iron kept cool by having water circulated through them. The table, which revolves slowly, carries the slag round to a certain point, by which time it has solidified. At that point it encounters a stream of water, which further cools it, and soon after it comes against a set of scrapers, which break it up and clear it off the table, delivering it into wagons placed below, and which convey it away.

SLAG SAND.

For producing slag sand, the slag is run from the blast furnace into a hollow wheel revolving upon a horizontal axis and fitted with iron buckets inside. A bath of water is maintained inside the wheel at the bottom, and is kept in a state of violent agitation by the revolving action. As the molten slag enters the body of water it is immediately disintegrated and assumes the form of sand, the water taking up the heat from the molten slag and giving it off in the shape of steam. A constant flow of water is maintained into the machine, and the sand is separated from it and elevated to the top of the machine by the bucket plates, which are perforated. Arrived at the upper part of the machine, the slag sand is dropped into a spout, and thence finds its way into wooden wagons, by which it is conveyed to the slag works for manufacture.

SLAG BRICKS.

The slag works occupy a main building 120 feet long, 50 feet wide, and five stories high, with basement beneath, and engine house, boiler house, and other accessories annexed. This building was constructed of slag cement concrete, composed of four parts of slag shingle to one part of cement, and it forms a very solid and comparatively indestructible structure. The slag sand is brought here from the blast furnace, and is tipped into stores below, whence it is elevated to the top floor by means of a hoist, which is fitted with an ingenious automatic safety brake, designed by Mr. Wood.

The special manufacture in this building is that of bricks, and, in carrying this out, two machines are used, one having been designed by Mr. J. J. Bodmer and the other by Mr Wood. For the Wood machine the sand is delivered into a hopper through a coarse screen, which retains any pieces of slag or other substances which may have found their way into the sand. Arrived at the floor below, the sand is automatically measured on a revolving cylinder, divided on the outside, and placed at the bottom of the hopper. From another hopper selenitic lime in powder is also measured by a similar contrivance, and the two substances unite in one shoot, where they become mixed in the proportion of ten parts of sand to one of lime. The mixture is carried down through a hopper into the pug-mill of the brick-making machine, where the two substances are further incorporated. This machine was designed by Mr. Wood, and is the outcome of considerable experience with another machine to which we shall presently refer, and which it has to some extent superseded.

Mr. Wood's brick machine has a horizontal circular rotating moulding table, which contains six pairs of moulds, four bricks being pressed at the same time. During the time of pressing, which is effected by direct mechanical pressure, the table remains stationary, and at the same time four other moulds are being filled and the remaining four are delivering the pressed bricks. As they are delivered, they are taken off the machine by two girls, and are removed to an air-drying shed—the machine producing from 11,000 to 12,000 bricks per day. There they remain for a week or ten days, after which they are stacked in the open air to harden, which occupies another five weeks or so, when the bricks are ready for the market. The bricks thus produced are very tough; they do not split when a nail is driven into them, and are largely used for interior work, for which they are well adapted, from the regularity of their surface and other qualities. They find a good market in London, and are not subject to breakage in transit. According to a certificate recently issued from Kirkaldy's testing works, some bricks taken from a stock of three years old were not crushed until a pressure of 21 tons had been reached. Others taken from a stock four months old were crushed with nine tons pressure, thus showing not only unusual toughness and strength, but that they were greatly improved by age. We thus have a curious anomaly of bricks being made without burning and of a wet season being favorable to the hardening process.

The second machine at the Cleveland Slag Works is that of Mr. J. J. Bodmer, and was the first one put up at the works. It is worked by hydraulic power, and has a horizontal revolving table with twelve moulds. The slag sand and the lines are mixed on their way to the machine, but the machinery for effecting the mixing is more complex than that used for Mr. Wood's machine. The rate of production in the Bodmer press is about the same as in the Wood machine, the distinctive difference between the two processes being that the former is worked by hydraulic power and the latter by direct mechanical pressure, Mr. Wood's machine possessing several advantages over that of Mr. Bodmer.

SLAG STONE.

In another department the manufacture of artificial stone is carried on, the stone being moulded into chimney pieces, window heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two and a half parts of finely-pulverized slag and two and a half parts of ground brick to one part of Portland cement. The mixture is run into moulds and sets quickly, the articles being ready for the market in four or five days.

SLAG MORTAR AND CEMENT.

Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag sand and common lime, the cement being composed of the same materials, with the addition of iron oxides.

Slag cement also forms the subject of a recent invention by Mr. Frederick Ransome, who has produced some very remarkable results. His cement consists of a mixture of slag sand and carbonate of lime, in the proportion of two parts of lime to one part slag sand. These are burnt together, and experiments show the result to be a cement possessing nearly 30 per cent. greater strength than Portland cement.

SLAG WOOL.

Perhaps the most beautiful, and certainly not the least remarkable, outcome of blast furnace slag is slag wool, or silicate cotton as it is also called, owing to its resemblance to cotton wool. The process originated, we believe, with Messrs. Siemens Brothers, on the continent, and the manufacture has been before attempted in England, but, as far as we are aware, has not succeeded. [The *Times* is mistaken about the origin of slag wool. It is an American invention, and was discovered and patented in this country.]

As carried out by Mr. Wood at the Tees Iron Works, a jet of steam is made to strike against the stream of viscous molten slag as it is run off from the blast furnace. This jet scatters the molten slag into a stream of shot, which is projected forward near the mouth of a large tube, in which a couple of steam jets cause an induced current of air. This tube opens into a receiving chamber, composed chiefly of wire gauze, and measuring about 33 feet long by 15 feet wide and 12 feet high. As each shot leaves the stream of slag it carries a fine thread or tail with it. The shot, being heavy, falls to the ground, while the fine woolly fiber is sucked through the tube and deposited in the chamber. The appearance of this chamber after a charge has been blown into it is singularly beautiful. Not an inch of floor, sides, or roof but is covered with a thick layer of the downy silicate cotton, bringing forcibly to mind the familiar words of the 147th Psalm:

"Large flakes of snow like fleecy wool."

After each blowing the wool is removed by forks, and packed in bags for consignment to a London firm—Messrs. Daniel Dade & Co.—who make it into mattresses which are used for covering steam boilers and for other purposes where it is desired to prevent the radiation of heat. For this purpose slag wool is eminently adapted, as it is a very bad conductor of heat, and is, moreover, perfectly incombustible. The make of slag wool at the Tees Works is about 3 tons per week, and as during the running of a 4-ton slag ball about 1¼ cwt. of slag wool is made, it follows that for producing these 3 tons nearly 200 tons of slag have to be operated upon.

SLAG GLASS.

Another useful purpose for which blast furnace slag has been successfully utilized is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its composition. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added with others which are not present.

Some years since Mr. Bashley Britten investigated this question, and in the end succeeded in utilizing for the manufacture of glass not only the material, but the heat of the slag. This latter is a very important point, inasmuch as upon it depends the economy of the utilization, and therefore its commercial success. The practical result of Mr. Britten's researches was the establishment by a company of some works at Finedon, in Northamptonshire, where the manufacture of glass bottles from slag is now and has for some time past been regularly carried on. The glass works are situated in close contiguity to the blast furnaces of the Finedon Iron Works, where the Northamptonshire ore is worked, and as the molten slag is run from the furnaces it is conveyed in carriers to the glass works. In these works a Siemens regenerative gas furnace applied to a glass-melting tank enables the preparation of the "metal" to be carried on continuously, affording a constant supply to the glass blowers. The ingredients of the glass are fed into the tank in charges of about 500 lb., the larger half of which is the molten slag, the remainder being the other necessary ingredients, such as sand and alkalies. In the tank these substances are fused and fined, the fused metal flowing through a bridge to the other end of the tank, where there are five working holes, from which the metal is taken by the workmen and fashioned into useful articles in the usual way. For the present the manufacture is confined to wine and beer bottles, of which about 90 gross can be produced per day. So far the results have proved sufficiently satisfactory to induce the company to extend their works, plans for which are in course of preparation. It is proposed to erect not only additional furnaces, but plant for the manufacture of other articles besides bottles, and for these a wide field opens itself. The glass produced is said to be stronger than ordinary glass, and the color can be varied as required, the natural tint being green. Its working qualities are said to be of the highest order, as it comes from the furnace in the best possible condition for the worker. Some bottles made at Finedon were sent to the Paris Exhibition last year, where they obtained honorable mention, a testimony at once to their character.

SLAG RAILWAY SLEEPERS.

A new method of toughening glass has recently been discovered by Mr. Frederick Siemens, of Dresden, and it is proposed to apply this process to slag glass for the purpose of manufacturing railway sleepers and other articles. Details of Mr. Siemens' process are not at present to hand, but, judged by results, it would appear to differ from that of M. De la Bastie, inasmuch as, when the toughened glass is broken, it does not fly into minute atoms as does De la Bastie's, but simply fractures, somewhat similarly to cast iron.

We have now taken our readers through these various interesting and ingenious processes, which are being carried on as ordinary commercial pursuits. The successful utilization of slag has a double importance—it not only helps to reduce the annual accumulation of a cumbersome and worthless waste product, but it adds new branches of manufacture to the industrial arts. Mr. Wood may be complimented upon his perseverance and congratulated upon his success. When in full work 450 tons of slag are produced per day at the Tees Works, and of this quantity about 1,000 tons per month are converted into sand for brick making, the average make with the two machines going being 110,000 bricks per week, the whole of which now finds a ready sale in the London market. We should mention that slag bricks are also being made at the Moss Bay Iron Works by Messrs. Kirk Brothers, who reduce the slag to powder first under edge runners, and then pass it between millstones. The powder is then moistened and pressed into bricks, which are hardened in the open air. The bricks are very good, but they are heavy, and are said to be expensive.

SLAG PAVING BLOCKS.

At the Acklam Iron Works blocks for paving streets, stables, and the like are being made from slag. The slag is there run into heated moulds, and after each block is formed it is removed from the mould and placed in an oven to anneal. These blocks are heavy, but wear well. In view of the general usefulness of slag when converted into the various articles we have described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilization may become more and more extended. Doubtless human progress will show that what is now the veriest waste will, in course of time, assume a condition of value. Thus will art be made to approximate to nature in that it will know no waste.—*London Times.*

MINERAL DEPOSITS—THE COMSTOCK LODE.

AT a recent meeting of the N. Y. Bullion Club, Prof. W. F. Stewart, of Virginia City, Nev., delivered an interesting lecture upon the subject of "Mineral Deposits." He said that geologists and mineralogists disagreed as to the method of nature in the deposition of minerals, and unless the true method could be determined, the country's mineral wealth could not be developed properly. He spoke of the old theory—that all the metals found were ejected from below the surface of the earth by volcanic action, and said that from the deductions from that theory external works were constructed by the first miners in this country, which only ended in the failure of the experiments. Men had argued that if the volcanic theory were true, gold, being the heaviest metal, would be found purer and in greater quantity at the lowest depths beneath the surface; but this had not proved to be the case. The Comstock Lode when first discovered was worked as a gold mine, and one half of its bullion was still heavily alloyed with gold. But it had been found that

the gold decreased in amount as a greater depth was reached. In California the gold decreased as the mining descended, until it finally ran into barren quartz. The Comstock Lode, however, at a depth of 400 or 500 feet changed from a gold into a silver mine.

The speaker said that it was a clear proposition that the gold in this country was a recent deposit, from chemical solutions taken from the surrounding rock by electro-mechanical force and deposited in the cavities of the earth. On account of this distribution of metals, debris and waste from old mines, which were formerly considered worthless, had been worked up and found to be most valuable.

Prof Stewart described at some length the supposed process by which the great rents had been torn in the earth. The earth, by some cause or other, had been split into chasms or fractures, nearly all having a polar direction. The principle of "polar cleavage" was the term applied to the law which governed the making of these fractures. The gold came from the sea, and the phenomenon of geological action was traceable to the influence of the sun Mr. Stewart said that when a mineral lode was found in one of the earth's fractures, it was what was called a true fissure. When the fracture was crossed by other chasms extending east and west, it could be assumed that some local action had taken place. When there were no cross fractures in one of these great chasms, no bonanzas were found, but at any cross fracture pockets of mineral deposits might be expected.

The great electrical currents of the earth determined the deposits, the currents keeping up a constant flow from north to south. Electro-magnetic action in the earth was the direct cause of mineral deposits. The amount of minerals held in solution, and the amount of electrical activity going on, determined the amount of the deposits Whatever metal in the rock dissolved first was first deposited The professor said that the auriferous deposits in California were subsequent to the great Jurassic period.

Mr Stewart spoke at some length upon the character of the Comstock lode and the future prospects of its exhaustion or further development. He said that some persons contended that the Comstock was not a fissure vein at all, but that the mineral was distributed promiscuously, in lumps, "like plums in a pudding." He was satisfied, however, that it was a true fissure. It was traceable as far as Pyramid Lake, a distance of fifty miles. But the region had been most wonderfully disturbed by geological action. Mount Davidson was one of the oldest mountains, and was popularly called a mountain of syenite. It had been in existence long before the deposit of the lava which now formed the Comstock lode. After the deposition of the mineral, there had taken place a great upheaval of trachyte, which had distorted the Comstock system of lodes. Mount Davidson was immovable, but the surrounding rocks were movable, so the lodes were crushed out of shape, and the creation of the cross fractures had made the deposit of the bonanzas possible. This crushing of the rocks also accounted for the chambers of water which were found in the Comstock mines, the powdered rocks absorbing water from the surface by percolation. The opening of the Sutro Tunnel had shown that this water was being rapidly exhausted. The water was not a continuous stream, as was contended by some, as the chemical elements in it were found to be different from those in the surrounding rocks in many places. Mr. Stewart paid a tribute to the value of the Sutro Tunnel, and mentioned as one of its benefits that it saved the expense of elevating the ore and pumping the water to the surface, a height of 1,600 feet. The ore was now taken right down the tunnel, and the water was expelled the same way. Another benefit derived from the tunnel was that it enabled thousands of tons of low grade ore, which was formerly thrown away because of the cost of transportation, to be taken down to the river through the tunnel, and worked with profit. Much of this ore paid $25 and $30 per ton.

In regard to the heat in the Comstock mines, Prof. Stewart held that it was caused by the action of electricity. When a fissure vein was broken, little heat was generally observed, and the fact of the great heat existing in the Comstock mines he believed to be proof that the lode was an unbroken vein. He thought that the maximum heat in the Comstock mines had been reached, but expressed confidence that if the heat did increase, it could "be easily managed by the employment of artificial means to overcome it." Mr. Stewart described the method of mining practiced on the Comstock, and mentioned the fact that telephones were in use in all the mines. In conclusion, he said that a fissure vein was never known to be exhausted, and recited several facts which "justified the confidence of the Nevada people in the inexhaustibility of the Comstock lode."

DE MERITENS'S NEW MAGNETO-ELECTRIC MACHINE.

Judging by the number of electric lamps that this machine is capable of lighting, it might be thought that it formed the most powerful magneto-electric generator for a given motive force. It might, in fact, with a motive force not exceeding one horse power, be able to keep three Jablochkoff candles lighted indefinitely, without requiring of the motor a velocity of over 700 revolutions per minute, and without the production of any appreciable heat. But the light furnished by these candles does not seem to be as strong as that from candles fed by the Gramme machine; and until we have more accurate measurements we cannot definitely judge of the relative power of this generator. The machine is magneto-electric, and furnishes, like the Alliance, reversed currents; but to produce the same effect it requires only eight Alvarre magnets instead of forty-eight, and only a fourth of the motive force; at least this is what M. De Meritens says.

The advantages derived from the use of this kind of a machine are due to the fact that to the induction currents set up in the ring of the Gramme machine are added those which are produced in the ordinary magneto-electric machines.

That we may understand this, let us imagine a Gramme ring (Fig. 1) divided for example into four sections, magnetically insulated from each other, and consequently forming four arched electro-magnets placed end to end. Let us imagine that the iron core of each of these sections terminates at each of its extremities in a piece of iron, A B, forming as it were an outspreading of its poles; and let us suppose that all these parts, united by a piece of copper, C D, form a solid ring, around which are arranged permanent magnets, N, S, N, S, whose poles alternate with each other. Now let us see what will happen when this ring shall have made a movement of rotation; and let us first see what will be the result, for example, of the approximation when the outspread pole, B, moving from left to right, nears N. At this moment an induced magnetic current will be developed in the electro-magnetic helix, A B, as in the Clarke machine. This current will be instantaneous and in an inverse direction to the Ampère currents of the inducing magnet; and it will be very energetic by reason of the proximity of B to the pole N But the ring in moving forward will set up a series of magnetic displacements between the pole, N, and the core, A B, and which will give rise to a series of

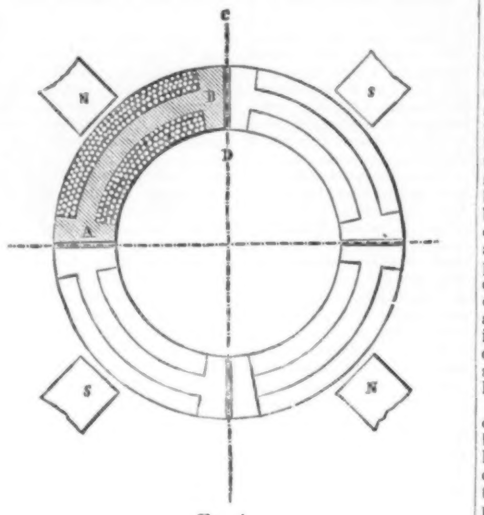


Fig. 1

polar interversion currents that will be exhibited from B to A, and these currents will be direct with respect to the particular currents of N, but not instantaneous, and will go on increasing in energy from B to A. Simultaneously there will be joined to these currents the dynamic induction currents resulting from the passage of the spirals of the helix before the pole, N. When A leaves N, a demagnetizing cur-

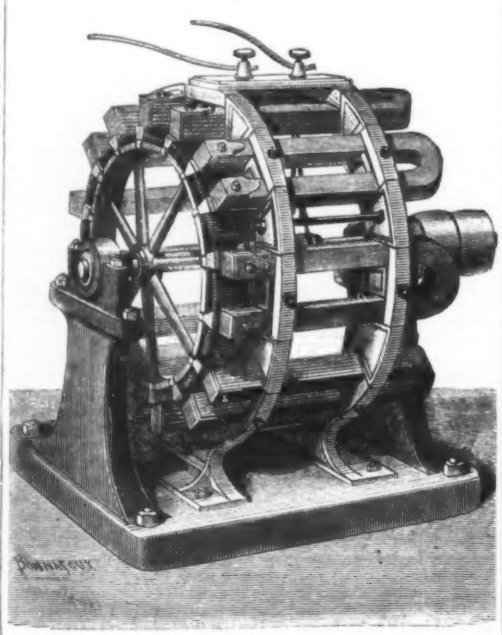


Fig. 2.

rent will be set up, equal in energy to and in the same direction as the magnetizing current resulting from the approximation of the outspread pole, B, to the pole, N. The effect is then produced, in fact, at a different extremity of the magnetic core, and the helix is submitted to the action of induction in an inverse manner. We have, then, inverse induced currents of the inductor caused by the approaching

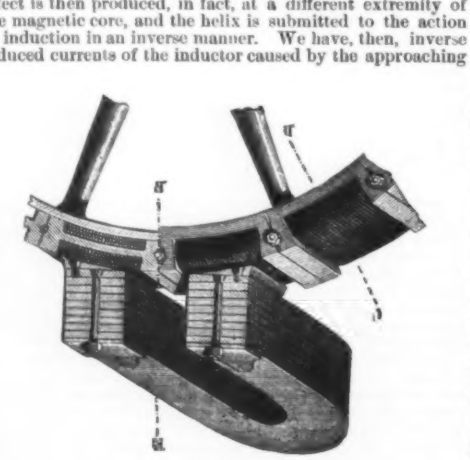


Fig. 3.

and receding of the appendages, B and A; direct induced currents during the passage lengthwise of the core, A B, before the inductor; and direct induced currents resulting from the passage of the spirals before N; in other words, we find in this combination all the causes of induction united.

It will be observed that the action that we have just studied with regard to a single section may likewise take place at the same time in all the others; and that to this are also added the currents resulting from the lateral reaction of the poles, A and B, on the neighboring ones. In order to still further increase the effects of induction, M. De Meritens forms the core, A B, and the appendages, A and B, of plates punched out of thin iron, as seen in the figure, and juxtaposed to the number of fifty in bundles, each plate being one millimeter (0·04 of an inch) thick. The wires of the helices, moreover, are so wound that they can be associated in tension, in quantity, or in series, according to the conditions under which they are to be applied. In the theoretical figure which we have considered, we have given only four sections; but in point of fact there are a larger number, and in the model of which we have spoken there are sixteen of them, and these may be readily distinguished in the figure (Fig. 2). They are mounted on a bronze wheel fitted to the shaft of the motor. Above this wheel are found the inducting magnets placed horizontally, and firmly fitted into two bronze skeleton frames (Fig. 3). A very slight inspection of the way in which the induced ring is placed will at once show that it could not possibly have been constructed in a better manner. Indeed, as each section is separate, it can be taken out by itself, and its wire consequently wound upon it without any trouble. Those who know the difficulties attending the winding of the Gramme ring will readily appreciate this advantage. On another hand, the fact of the core being composed of juxtaposed plates, which may be cut out at a single blow of the punch, also presents an immense advantage; for this system dispenses with the precision that is necessary in constructing these rings, which are always so difficult to keep perfectly round. Finally, there is neither a commutator nor collector in this machine, and consequently no loss of current.

We have seen that the currents furnished by this machine could light three to four Jablochkoff candles; but it has been found equally possible to light regulators, and in the latter case it has been found possible, too, to separate the carbons as far as 5 centimeters (2 inches) apart without extinguishing the light. These results are certainly very important.—*Th. du Moncel, in La Nature.*

MR. JAMIESON'S LECTURES ON ELECTRICITY AND SUBMARINE TELEGRAPHY.

First Examination Paper (*Four Hours Allowed for Examination*).

N.B.—Answer any *ten*, but only *ten*, of the following *twenty* questions. The full value of marks obtainable is 1,000, and 800 marks must (at least) be obtained in order to get the prize. The value of each question is 100 marks.

1. What is the word *electricity* derived from? By whom and when were electrical effects first produced?
2. Mention the three distinct periods into which the history of electrical science naturally divides itself.
3. Give a brief account of Franklin's experiment with his kite. What objects had he in view? How was his kite constructed, and what were the materials he used?
4. Give five examples of how frictional or statical electricity may be generated.
5. What is the difference between a conductor and an insulator? Name *six* good *conductors* and *six* good *insulators*.
6. Explain clearly the different effects which moist air, dry heat, and flames have upon a highly-charged insulated body.
7. In what year and by whom were the terms *vitreous* and *resinous* electricity first adopted, and for what reason?
8. Give the modern terms, or those now used for vitreous and resinous electricity, and enunciate the laws of attraction and repulsion with regard to them.
9. Make a sketch of the electrical plate machine used at the lectures for generating frictional electricity.
10. Explain the electrical action of either the *plate* or the *cylindrical* frictional electrical machine.
11. Give a sectional sketch of the ordinary condenser used for submarine cable working. In what respects is it similar to the Leyden jar?
12. Upon what laws do the charge and discharge of condensers depend? Enunciate them.
13. Sketch in section an ordinary Daniell's cell. Mark the names of the several parts and ingredients, and give the chemical action which takes place when it is worked.
14. Draw Sir William Thomson's tray cell, explain the best plan of setting it up, and keeping it in good working order.
15. Give a section of Sir William Thomson's mirror galvanometer, and explain details.
16. State the laws of attraction and repulsion between parallel wires in which currents are passing in the same or opposite directions.
17. Give a cross section of the *Mouse Mill*, and explain its action in full.
18. Give a diagram of recorder (Sir William Thomson's) connections for one station, with condensers, keys, etc.
19. Give a section of the ordinary deep-sea type of submarine cable, name the parts, and explain briefly how it is manufactured.
20. Name the units of resistance, capacity, electromotive force, and current, and state *Ohm's law*.

Andrew Jamieson, C. E.

ANIMAL ELECTRICITY.

An important paper on the results of recent researches in animal electricity is published in the *Nature*. The author, Dr. L. Herman, states that the whole of the electrical phenomena of muscle and nerve may be readily deduced from a few very simple propositions. Irritable protoplasm responds both to destructive and to exciting influences by an electromotive sign. The altered substance takes on a negative potential with respect to the unaltered. This, together with the doctrines of internal transverse polarization and of the polarizational increment of excitation, appears fully competent to explain all the facts hitherto observed.

FIRE DAMP IN MINES.

For the purpose of ascertaining the presence of fire-damp in mines, Millard and Le Chatellier use a lit jet of hydrogen, which gives a larger and more distinct blue aureola than the flame of the common safety lamp when the quantity of the dangerous gas is even very small This expedient has revealed the presence of 0·25 per cent. of fire-damp. The flame, which is inclosed in a copper tube, is viewed through a lens in the side of the tube.

ON NOCTURNAL ANIMALS.*

By James Murie, M.D., LL.D., F.L.S.

A consideration of all that is known respecting the habits and manifold peculiarities of those animals whose active phases of life come under the denomination "nocturnal" is manifestly impracticable within the limits of the present paper. A selection of instances in point, therefore, is unavoidable. In this case preference is given to the Vertebrata, inasmuch as many are familiar objects in our public gardens and traveling menageries.

Scarcely one of the sub-kingdoms and classes of animals can be named but has a subordinate group, or more often a limited section, or species of a group, which, in contradistinction to its fellows, exhibits abnormal habits and manifests a preference for darkness over daylight. Very frequently there is associated with this exceptional habit some diversity in organs and subsidiary structures adapted to the creature's particular mode of life. Still occasionally where no pronounced structural differences are observable one is at a loss to account for singularity of habit. Something, therefore, which is not always apparent may underlie this tendency to variation.

Can it be that one or more dominant though hidden forces are at work that at least would partially explain this enigma? Or are animals actuated by the varied motives which influence reasoning mankind, subdued and modified, as a matter of necessity, from imperfection in their structural detail?

Carlyle has quaintly said that "the two great moving powers of society are hunger and the policeman." Sternly inexorable is the former, a humiliating necessity the latter. Now as animals must eat to live, it is not unnatural that they should be found abroad at such times as their prey is most easily procurable. Moreover, they have cautiously to avoid their own enemies, and thus find safety in feeding under cover of darkness. But besides the craving for food there seems another influence which, though at first less recognizable, is possibly much stronger in its potency, namely, an inclination to seek shade. Throughout the animal kingdom, generally, but more especially among the lower forms, examples of this are numerous. Coincident with an uncomfortable feeling, howsoever produced, is retirement to shade. In short, light acts as a stimulus, not equally shared by all creatures. Its influence on protoplasmic matter is evident, and is of continual occurrence even among animals of most imperfect organization. Traced upward from these, the reception of sensory stimuli presents us with superadded or adaptive structural modifications often rendered acute to a degree.

How gradual development from simple to more differentiated conditions has been brought about in the march of time, and what may be the relation of transmission of qualities from parent to offspring, I leave unanswered as involving discussion apart from the immediate purport of this article.

Premising that nocturnal activity is the sequence of an endeavor to shun light, as annoying or detrimental to the organism, and that in certain cases search for food or other functional impulse necessitates nocturnal habits, I shall confine my remarks accordingly.

In using the term "nocturnal," I would wish it to be understood in its widest sense. Thus the great mass of animals are abroad, feed, and otherwise are actively employed, so to say, *in their business of life*, during daylight and sunshine, that is, from morn till eve. Not a few, however, from preference or necessity, are then in retirement, from which they only emerge between nightfall and sunrise. Others choose twilight or the "gloaming"—that hazy obscurity which precedes the setting in of night; while others, again, roam at early dawn, when stillness and imperfect light prevail. The term "diurnal," in strictness, is applicable to the first mentioned; the three others may therefore be classed under the head "nocturnal," although the term "crepuscular" is not unfrequently employed to designate those animals whose habit it is to issue forth in the glimmering betwixt light and darkness.

But the limits of separation are not easily defined, notwithstanding breadth employed. Take mankind collectively, and without hesitation they would be classed as diurnal creatures; yet a moment's reflection will show that, either from choice or necessity, many individuals lead a truly nocturnal life. Nor can it be said the crepuscular element is here wanting, albeit the use of artificial light. Again, Herbivores, the Deer tribe particularly, are diurnal, yet under certain conditions—*i. e.*, during the breeding season—they temporarily become night roamers. Other somewhat corresponding instances of change from ordinary habit may more fitly be referred to in the sequel.

An explanation of some of the peculiar phenomena observable among Nocturnal Birds and Mammalia (Bats, to wit) would be incomplete without a due consideration of the senses and sensory organs of a few of the inferior orders of the Invertebrata, as elucidating fundamental principles.

Quite at the bottom of the scale which zoologists have to deal with are the group of Protozoa—creatures all more or less of the simplest construction, and for the most part microscopic in size. Little is there indeed to be shown in the organization of such a form as *Protamœba primitiva*, Haeckel, where alone a faint grayish color and translucent, granular, gelatinous substance is recognizable. This jelly-like material, notwithstanding, possesses all the essentials of animals far higher in the scale, inasmuch as, without any organs whatsoever, the necessary functions of organic life and reproduction are performed. Its sarcode is sensitive to impressions, *viz.*, subject to irritability; hence contraction and expansion, *i. e.*, movement. It suffers waste of tissue, hunger follows, and supply means assimilation of nutriment at at any point, and simple division means reproduction. But as bearing on our question at issue, of greater signification is the remarkable property of this jelly's having a diffused sense, equivalent to touch. Thus this so-called sixth sense of some writers, modified in a variety of ways, becomes an important factor in all that relates to adaptation to "nocturnism," if such an expression is admissible.

Possibly the above and others of the Protozoa are not strictly nocturnal, though some shun direct sunlight. But whether heat-rays may have a determining influence is an open question.

Among the Medusæ, or Jelly-fish (*Cœlenterata*), which, though met with during the daytime, abound most frequently in calm, clear weather at the surface toward nightfall or when complete darkness has set in, sensory organs of a most rudimentary kind are developed. Nerveless, as ordinarily understood, yet, according to the recent researches of Romanes, Eimer, and others, defined lines of sensory impressions exist in the sarcodous jelly of their umbrella. In fact, reflex action is apparent, minus true nerves. A few minute calcareous particles aggregated together or within a sac scattered toward the periphery of the umbrella, acoustic vesicles, are forerunners of organs of hearing; and for eyes there are pigment spots at the base of the tentacles, the latter themselves being feelers.

Thus the Sea-blubbers are instructive as evincing diffused sensation along with localized spots wherein this touch becomes, by slight differentiation of tissue, instrumental in the production of hearing and sight, of course, in an inferior degree. Although absolute proof is wanting, it is quite within the range of probability that their stomachal cavity appreciates in a faint degree approaches to a low kind of taste and even smell. In some genera more diurnal in habit, their extreme sensitiveness to light is manifest by their immediately closing and descending when heavy clouds dim the atmosphere.

The foregoing well illustrates Mr. Herbert Spencer's views ("Principles of Psychology"), viz.: "For every higher phase shows itself as an ability to recognize smaller and smaller differences, either of kind or degree, in attributes of surrounding bodies; and so render it possible still further to specialize the adjustment of inner to outer relations."

In nocturnal animals this principle is carried to its fullest extent, all adaptations to habit being connected with endowment of extra sensitiveness specialized.

The Annelids, however, afford plentiful examples of preference for darkness; and the common earthworm is both easily observed and procurable for examination. Except in damp weather and dull days they are shy, and not much given to be abroad, but in the evenings, all through the night, and early morning, especially during moist weather, they crawl hither and thither with unrestrained freedom. Keen fishermen know when best to seek their bait, and the proverb of the "early bird finding the worm" points to gray dawn.

Here, then, we see that the nocturnal habit of the one creature superinduces the necessity of similar habit in the other. The bird's own enemy, again—it may be reptile or mammal—must stir betimes, and thus, from class to class, the nocturnal and crepuscular habit is transmitted. Once acquired and perpetuated, modification of organs adapted to the altered circumstances ensues. Tactile sensation among groups of the Vermes is through minute skin modification,

NEW ZEALAND NIGHT PARROT.—*Stringops habroptilus*, Gray.

papillæ, bristles, or cup-shaped bodies, all in connection with the nervous system. Though the earthworm itself is blind, it is not so with others, where evolution of visual organs from indifferent condition to complex lens, crystalline rods, cones, etc., is well marked. Auditory organs are also present in some.

With regard to the Mollusca, and with them we may associate the Crustacea, some doubtless are nocturnal; others live at depths where only a modicum of light is admissible. Not a few retreat to darkness under cover of rocks, stones, and sea-weed. But slugs and snails are active after sundown, and all night long commit their ravages, while their reptilian and avine pursuers have to follow suit.

Of Arachnida, Myriapods, and quite a host of the division of Insecta, one is at a loss by the *embarras de riches* of those that carry on their life occupations under cover of darkness. Suffice to recall some of the Trap-door Spiders and their ingenious devices, so graphically portrayed by Mr. Moggridge, while to those who have felt the effects of the nocturnal attack of the venomous Scorpion, the name is sufficient.

Deeply interesting is Mr. Moseley's researches on the caterpillar-looking nocturnal Myriapod of the Cape of Good Hope (*Peripatus capensis*). It is there quite local in habitat, and is found under dead wood, wherefrom it creeps out at dusk. A pair of horn-like antennæ project from its head, and it crawls by the aid of seventeen pairs of hooked, conical feet. It breathes air by trachea and stigmata. Cutaneous glands secrete a viscid fluid, which, Capt. Hutton asserts, is thrown out, as if by magic, in fine thread-like jets, and by this viscous web insects are caught and afterward devoured. Mr. Moseley believes this creature is of great antiquity, and the ancestor of spiders, Myriapods, and insects. If so, then nocturnal habits are not of recent introduction. The variety and modifications of apparatus manifest among nocturnal insects, and as adaptive to that habit, almost forbid attempt at selection of instances.

The Vertebrata have their full share of night-hunters, and equally can Fish, Amphibia, and Reptiles be cited.

When we come to Birds (Aves), we find that although the majority are diurnal, yet many are habitually crepuscular—either found on the wing as the sun goes down, or abroad for their living early in the gray dawn. These very often pass the daytime tranquilly or dozing under shade, and stir about between lights, though roosting at night. Birds with young are urged by the maternal instinct, and will then keep late and early hours, quite out of their usual way.

But in generalizing on nocturnal habit, it should not be forgotten that what applies to the northern regions does not always hold good of the tropics. As we near the equator, sundown all the year round means quick and often intense darkness, to be continued till sunrise, and, consequently, there is a certain seasonal uniformity in animal habit. In higher latitudes summer twilight stretches further on, and the first blush of the morning quickly succeeds. It follows that diurnal groups of birds and mammals of the tropics acquire more crepuscular habits the further north they go, particularly in the summer season, and winter weather correspondingly brings change of hours.

The Struthionidæ (Ostrich group) attract attention in having one New Zealand genus, the diminutive *Apteryx*, which is a night-hunter. It might be interesting to know if its island congeners, the great extinct species of *Dinornis*, were also nocturnal—a question easier asked than likely to be satisfactorily answered, though I should say they probably were.

The night habits of the *Apteryx* are well attested those confined in this country being as shy of daylight as their wild brethren in New Zealand. Selecting a dry hole in sand, tree, or log as their usual abode, or artfully concealing themselves among the dense beds of fern, the Kiwis lie, generally in pairs, torpid and drowsy while day lasts. The approach of night sees them awake and hunting hither and thither for their food. This is not of a vegetable nature, but consists of worms, snails, lepidopterous larvæ, and such insects as they come across. At such times the very marked peculiarities of the long, narrow, terminally knobbed beak, the loose, freely movable brush of tactile rictal vibrissæ, the hair-like feathers set all over the body, and short, stout legs, are plainly adaptations fitted to its nocturnal search for food. As regards the eye, this has an absence of pecten or marsupium compatible with night habit, and it is relatively smaller than in the other Struthionidæ. This is amply compensated for by feathering, and especially the extremely sensitive vibrissæ. These at every motion of the bird inwardly convey impressions of touch, and guide it among the dense grass and vegetation where sight might be less available. It is said to make a sniffing noise when searching for food, possibly produced by the imperfect closure of nostrils placed, most unusually, at the bulbous extremity of the beak, as this latter is inserted among the loose soil and herbage. But at all events the careful dissections of Professor Owen show that the organs of smell and taste, as well as hearing, are unusually well developed. In this case the point of the bill, with its nerve-endings, has a sense of most delicate touch over and above olfactory power. Without going into other detail of structural differences between the *Apteryx* and others of its order, enough has been said to show that functionally the former is modified to adapt it to nocturnal habits.

Among the noisy diurnal group of Parrots (*Psittaci*) are two night-roamers. One of these is a New Zealand form, and the other a native of Australia.

Of the singular New Zealand Night Parrot, or Kakapo, as the natives name it (*Stringops habroptilus*), Dr. Günther informs me that it is reported as a perfect nuisance to the shepherds. In the dark it steals among the sheep, and, mounting their backs, vigorously searches for all the ticks and vermin it can find, but in the search it not unfrequently tears the skin and flesh as well as the wool. In this respect it is a bad imitator of the African Oxpeckers, *Buphaga*. The *Stringops* is a larger bird than *Geopsittacus*, presently to be mentioned, though intensely like it in its sap-green color, markings, and outward aspect generally. It has a dazed eye during the day, indicative of moderate light being most suitable for perfect vision. The wings are relatively short and rounded, and although it has parrot-like feet, yet these are adapted more for ground-running than grasping. It has a somewhat strigine face, the radiating feathers around the eyes simulating the facial disk of the Owl's, while numerous tactile hairy feathers prominently occupy the root of the beak. Dr. Günther's statement, as above, denotes an insectivorous bird, or one that would not despise worms or other vermin, but other information on its habits leads to the supposition of a preference for vegetable food. Dr. Sclater remarks of that living in the Gardens in 1875. "The *Stringops* is most strictly nocturnal in its habits, and never emerges from the box in which it is kept, voluntarily, during daylight. Our specimen has no power of flight, but uses its wings to aid it in running. It feeds upon oats, apples, lettuce, carrots, and other vegetables, and appears to thrive well upon this diet."

Sir George Grey records of the Kakapo that during the day it remains hid in holes under the roots of trees or rocks, rarely perching. Sleepy and stupid as it hides among the grass during the day, at sunset it becomes lively, animated, and playful, then feeds, with a grunting noise of satisfaction, on grass, weeds, fruit, seeds, and roots. It grazes or nibbles the grass in the manner of a Rabbit or Wombat.

In Mr. D. Lyall's account of the wild bird, in his communication to the Zoological Society, he mentions that at the southwest of the middle island of New Zealand he found them living in communities on flats at the river's mouth near

* This article is based upon a lecture delivered by the writer during the present summer, in the course of "Davis Lectures," at the Zoological Society's Gardens, London. It has been modified, however, in some respects, and especially in the elimination of much that was stated with regard to the lower forms of life.—*The Zoologist.*

the sea, and more hillwards; tracks a foot wide abound where they run about. As many of the roots of trees are above ground, the Kakapo burrows among them. Flight was rarely seen, and then for very short distances, the wings scarcely moving, and the bird, alighting on a lower level, only gained height among the hollow trees by climbing, the tail assisting. It is seldom or ever seen during the day, and dogs are used to hunt it. Indeed, the dogs which have run wild, with the cats, besides man, are rapidly exterminating this strange Parrot. There can be little doubt, he says, that their food consists partly of roots (their beaks are usually more or less covered with indurated mud) and partly of the leaves and tender shoots of various plants.

Another writer, Mr G. S. Sale, who kept one alive in this country some time, says its playfulness is remarkable; it will run from a corner of the room, seize the hand with claws and beak, and tumble over and over with it exactly like a kitten, and then rush back to be invited to a fresh attack. It is also humorous, dancing with outstretched wings, evidently shamming anger. It is generally lively enough during the day, but not so noisy as at night.

The Western Ground Parakeet (*Geopsittacus occidentalis*, Gould) has considerable resemblance to *Stringops* and to *Pezoporus*, another ground-loving Australian Parakeet. *Geopsittacus*, however, lives in rocky caves and comes out at night to feed, as Mr Ryan, of the Gawler Ranges, Spencer Gulf, assured Dr. Müller, and this is corroborated by Mr A. D. Bartlett's observations on a bird in the Zoological Gardens. As might be expected from its habits, the wings are like those of many night-flying birds; the eyes, of moderate size, in daylight have a strange hazy expression, not easily described, but quite characteristic of nocturnal animals. The cere is unusually full and fleshy, with wide nostrils, and a pencil of elongated hair-bristles below. The bird appears to be a vegetable-feeder, and is almost noiseless, uttering very rarely a harsh double note.

The Owls (*Strigidæ*) present some strange modifications, and prominently display the fact that organs, by almost insensible gradation of structural change, are equally adapted for use by daylight, semi-darkness, and night. Only intensity of sensory power is secured where absence of light is essential to their well-being. What more applicable to noiseless flight than their fluffy feathers, whose lightness is strengthened by additional serrated delicate barbules interlocking and giving the gossamer framework efficacy for nocturnal purposes? Their great curiously-set eyes, with enormously broad iris and other anatomical attributes, so dazed in the sun's glare, light up and receive every faint ray of night reflection; their auditory apparatus, with great open tympanum, downy plumage, and circlet of feathers, in substitution for an auricle, guiding and concentrating sound, however faint, to the recesses of an ear specially constructed as a receptacle for appreciation of vibratory movement. The facial disk, the peculiarities of cere and nostrils, the beak and talons, all betoken adaptive power as aerial night-hunters.

The Nightjars (*Caprimulgidæ*) are equally creatures of night; but, unlike the Owls, their enormous gaping mouth, defended by stiff bristles, is an adaptation implying hunting and securing prey on the wing. Swallows of the night, the Goatsuckers possess a plumage vying with the Owls in soft delicacy and lightness. The eye equally and specially conforms to the principles necessitating vision in the uncertain haze of twilight and night. The diminutive weak legs present no characters of a percher, and the bark-like plumage of the bird, when resting and cowering on boughs, protects it from its diurnal enemies. It has a peculiar pectinated claw on the middle toe, which may either facilitate its balance on a bough or be used as a cleansing tool when broken moth's wings stick around the gape. No nocturnal beetle or sphinx moth, however powerful on the wing, is safe from the noiseless circling sweep or rapid dash of "the awaken'd Churn-owl."

Many other birds besides the foregoing are nocturnal; but these illustrate sufficiently how sensory organs are correlated with crepuscular habit.

In passing to Mammals, numerous groups are found with decided night tastes. Monotremes, Marsupials, Edentates, Rodents, Carnivora, Insectivora, etc., all furnish marked examples. Some are burrowers, others partially aquatic, others again arboreal, no animal profession being unrepresented.

The Cat tribe is familiar. Their cushioned feet give softness of tread; their hearing is exceedingly good, though their outer ears may be small. Long bristly whiskers stand out, and as tactile organs quickly convey impressions of surrounding objects. Smell, too, is acute, though not used equally by all to obtain prey. Sight, however, is most relied on. The greenish or sometimes reddish glare of the feline eye is familiar, as well as that of other nocturnal mammals. This is produced from the *tapetum*, a brilliant iridescent membrane immediately beneath the retina, whose finely ribbed surface produces the coloration as an interference phenomenon.* The ensheathed sharp claws and cat-like and muscular development of the body complete organisms all highly adapted for the capture by night of often powerful prey.

But even in the case of Ruminants which, as a rule, are diurnal, night excursions among the vast African herds occasionally happen. The Grysbok during the day lies hid in reed beds, and regularly feeds at night.

The Elephant and the Tapir are often night-roamers, want of water being a chief incentive with the former; its great ears as tactile organs are then useful in treading in the gloom of the forest.

The Star-nosed Mole (*Condylura*) and the Urotrichus may be cited as instances where the lengthened nose, having fringed processes of a tactile kind, supplies this deficiency of sight

Among the entire range of nocturnal animals none exhibit so strikingly, or in so high a degree, the diffused sense of touch (referred to when speaking of the very lowest animal forms) as the Bats (*Chiroptera*). So accustomed are we to associate them with the dusk that when the writer once saw, in Central Africa during the middle of the day, a flight of literally myriads of great Fruit Bats, he was as much astonished at the diurnal spectacle as at the numbers. They covered the sky like a cloud, and kept steadily passing over for many minutes. Though keen-sighted, bats generally have rather a sharp rat-like eye than an ocular apparatus indicating a large field of vision. The dark color of the eyeball, as a rule, prevents the contraction (often to a pin's point) and expansion of the iris and pupil being readily noticeable, though there is considerable power in this respect. But if the eye of a large Bat, such as that depicted in the woodcut, be attentively observed when exposed to the strong glare of sunlight, that hazy, lusterless expression so indicative of night habit is readily appreciated.

Hearing in these animals is a well developed sense. Not only is the internal ear a highly efficient organ, but, as is well known in several of the Bat families, the enormous size of the thin membranous conch is out of all proportion to the dimensions of the animals themselves. Moreover, the tragus, especially in the *Nycteridæ* and *Vespertilionidæ*, is extraordinarily exaggerated. The external nasal apparatus, even in our English Horse-shoe Bat (*Rhinolophus*), is an extremely absurd looking nose-leaf, but in the Vampires (*Phyllostomidæ*) and Megaderms the same part, in size, complexity, and ugliness, almost exceeds the ridiculous. Smell, in fact, like hearing, has a superadded intensity, through the exterior apparatus and its wonderful tactile power. Taste, in the Fruit Bats, at least, is in no way deficient, though probably little influencing nocturnal peculiarities. Concerning touch, it is the strangest physiological problem in the whole history of their economy. The wing membrane of a Bat, most persons are aware, is a thin tegumentary extension stretched between the enormously lengthened but attenuated bones of the hand (see figure), that is, both palm and fingers. At one bend, that which represents the wrist-joint, is a short-clawed grappling hook, the thumb. The lower and upper arm bones are each greatly elongated, especially the former. This long levered arm, which otherwise would be weak and futilely beat the air when outspread, is further strengthened and improved as an organ of flight by a delicate though tough web running out like a guy-rope in front. Furthermore, a continuation of broad web reaches from the inner finger and arm to the body, and onwards to the heel. The form of the tail varies in different genera, and is capable of being extended according to the length of the membrane by which it is attached to the sides of the leg. Throughout all this extent of membrane highly elastic tissue and minute muscular fibers are so distributed

THE COLLARED FRUIT BAT.—*Cynonycteris collaris*, female, showing mode of carrying young.

that the web can be partially or wholly furled as circumstances require.

The young cling to the mother by clutching her most tenaciously, and she flies about or roosts head downwards, enveloping her offspring with the wing membranes. But the wing and leg-webs, the great membranous ears, and, indeed, all the sinuosities of facial and nasal flaps, etc., subserve a sensory purpose necessary to the well-being of these nocturnal creatures *par excellence*. Though often transparent, flesh-like, and seemingly bare, yet everywhere, and scattered on both sides, are extremely slender, delicate hairs, the bulbs of which widen out and inclose minute tactile organs (*Tastkorperchen* of Dr. Schöbl). Added to these, fine nerve-threads are freely distributed; and, as if further to enhance the extreme sensibility of the part, a perfect network of contractile capillary blood vessels.

Hence, as in the Amœba or Jelly-fish, every particle of the surface is a tactile apparatus with a sensitiveness possibly unrivaled in the animal kingdom.

For a long time it was inexplicable how Bats flew in the dark with unerring certainty. The remarkable experiments of the earnest and shrewd Abbé Spallanzani showed that, after eyes, ears, and nose were destroyed or obliterated, so far as sensation or use was concerned, the mutilated creatures avoided every minute obstacle placed in the way; they even threaded dark caverns, and found out nooks and crevices in a most extraordinary manner. That the result of these experiments was not mere accident or good luck on the part of the Bats has been shown by Jurine and Schöbl, who repeated them. Moreover, the careful microscopic researches of the latter have revealed, as above stated, structural conditions not previously suspected.

One can no longer wonder, then, how important and efficacious to crepuscular and night-roaming animals are long vibrissæ, erectile spines, filaments, and such like organs, as well as the tactile delicacy of palm, pads, etc.; in fact, impressions are by these means conveyed, which to diurnal animals are unknown and unrequired.

Though not absolutely rivaling the Bats in constancy of nocturnal habit, or endowed with the sense of touch in its broadest aspect, still the *Lemuroidea*, or Half-apes, as some naturalists designate them, are marvelously interesting, from their adaptive structure to nocturnal habit. Some are cat or fox like in build or expression, others puggish; all are quadrumanous, with big opposable thumbs and great toes; a few possess abnormally developed fingers; none are so intelligent and mischievous as monkeys. These of the genus *Lemur* are much more diurnal in habit than their congeners, or rather, they are out morn and eve, and often sleep of a night. But the majority of lemuroids are, truly speaking, nocturnal animals.

The "night-eye" is dominant, with its vertical and changeable pupil, passing from faint streak to wide circle. Most of the species have thick tactile whiskers. The abnormal bulbous tips of the toes are quite peculiar looking, but their utility is explained by the fact that each pad is an exquisitely sensitive apparatus, possessed of a marvelous power of touch. These creatures see, as it were, through their fingers, like the blind man. There is much difference with regard to ears. In the Loris group they are of moderate size; the Tarsius, the Aye-Aye, and Galagos, on the contrary, have great bat-like ears, the latter singularly movable. All are most sensitive to changes in temperature, and soft furry coats are noiseless protectives in their night rambles.

As each group of the Lemuroids is constructed, *sui generis*, for night exploration, a brief glance at one or two of the most singular is all that can here be taken.

The Potto or Bush-dog (*Perodicticus*) is one of the stumpy, West African, slow-moving species. A short tail and well nigh obsolete forefinger are its chief exterior characteristics. Its habits are so similar to the better known Asiatic Slow Loris (*Nycticebus*), that reference to the latter will serve both. Seen in the daytime, or made to walk on a flat surface, from its weird-looking eyes, sack-like body, long limbs, and slow straggling gait, one would predicate it the worst of night-hunters, but give it a grasping surface, and place a beetle before it at night, the eye lights up like a globe of fire; the quiet demeanor and sudden rush on the prey is astonishing. The perfect silence in movement, tenacity of grasp in climbing, tactile appreciation, and dilatable eye, all enable the creature stealthily to approach birds, insects, and creeping things, and to snatch at and secure them in a twinkling.

The great-eared Javan Tarsius, and the African Galagos, on the other hand, are perfect imps of nimbleness. Their furling ear-conch catches every sound, their sensitive palms and facial vibrissæ warn them of every obstacle in their path, and the unusually lengthened heel-bones, like frogs, enable them to spring astonishing distances, so that they are on their prey like lightning.

The great-eared Aye-Aye of Madagascar, so lucidly described by Professor Owen, is even more curiously adapted for its peculiar nocturnal rambles. It seems almost blinded by daylight, but brilliantly orbed in darkness. The two middle forefingers are bat-like in tenuity and length, and probe nook, crevice, and corner with super sensitive tact and skill. Its whiskers and skin warn by delicacy of touch, and its strange rodent-like teeth serve as effective chisels in night hunts for creatures, the presence of which ear and finger alone indicate.

The Lemuroids, as a whole, then, embody perfection in varied apparatus useful nocturnally. As with the Bats, Mr. Herbert Spencer's principle is highly applicable, *viz.*, "There can be no doubt that the sensation of touch and pressure are consequent on accelerated changes of matter produced by mechanical disturbance of the mingled fluids and solids composing the part affected."

The Douroucouli (*Nyctipithecus*), a small animal allied to the Capuchin and Squirrel Monkeys of South America, decidedly leads a nocturnal life. Several species have from time to time been kept at the Regent's Park Gardens. Visitors seldom see a specimen; for like the Slow Loris (*Nycticebus*), it cuddles up during the daytime and seeks shelter in its box. When poked it seems bewildered by the light, and the eyes present the dazed appearance common to the Nocturnal Lemuroids. Like the latter day sleepers, it brisks up at sunset, and then is active, when all other of the monkey tribe slumber. In general anatomical structure it resembles the *Cebidæ*; but the molar teeth are tuberculate; the iris has great power of expansion and contraction, the

* There are two forms of *tapetum*—1st, cellular, as found in fishes and carnivora, whose cells contain lime-crystals in the former, seldom in the latter; 2d, fibrous, as found in many other mammals.

great round pupil at night giving quite a different expression to its contracted diurnal aspect; and lastly, the palms of the fore feet exhibit more tactile properties than is common to the generality of the monkeys. Functionally, therefore, eye and finger tips, or sight and touch, have become extremely sensitive to impressions, by a change in the minute tissues of a very limited kind; but they are just sufficient, along with the slight dental cusps, to effect a radical change adapted to night habit and insectivorous food. In the dark virgin forests, the Douroucoulis after nightfall nimbly lay hold of small birds and chase the spiders, beetles, cockroaches, and other nocturnal insects—even bats they are said to devour—though they by no means despise sugar-cane, fruit, and nuts. In the Zoological Gardens, it is difficult to rouse the creatures during the day; but Mr. Bates says that in the Amazons they are aroused by the least noise, so that when a person passes by a tree on which a number of them are concealed he is startled by the sudden apparition of a group of little striped faces crowding a hole in the trunk.

VAN BOSMAN'S POTTO.—*Perodicticus potto*, Gmelin.

Thus true Apes and Monkeys (*Quadrumana*), with the single exception of the South American genus above mentioned, are in the full swing of their ceaseless activities and eccentric pranks in broad daylight. Just before sunset, when in the forest, one occasionally hears a chattering noisy lot either settling friendly differences or having a final "scrimmage" ere repose, but no sooner has gloom spread than all is hushed. Even in our Zoological Gardens, where the creatures feel secure from night attack, their silence then is in marked contrast to their companions, the Lemurs. Some monkeys when in their native haunt are astir at gray dawn, and in bands make for the nearest plantations, commit ravages, and scamper off before the sun has got up well in the horizon. Man has then his part to play; and so by interdependence of habit, from lowest to highest of the animal kingdom, the round of night labors and watchfulness goes on.

In a mere sketch like the present the subject obviously receives but scant justice; for many interesting nocturnal animals, peculiar habits, and curious structural conditions suggest themselves, of which no mention has been made. Nevertheless one may be justified in a retrospective summary of the points influencing, doubtless to some extent, nocturnal habits.

All animals suffer waste, and necessarily require food and drink to repair waste of tissue. To supply these they must needs obtain them at such times and places as they are procurable.

Animals, moreover, are influenced by the surrounding medium and environment generally, and light especially, as well as temperature, often cause uncomfortable sensations.

Many hence endeavor to shun excess of light, and, in so doing, seek night or cool twilight to perform their active functions.

By dependence upon one another for sustenance, by precautions of safety against enemies, and occasionally by seasonal occurrence of procreative faculties, or the rearing of offspring, and by other economic reasons, nocturnal habit may be acquired, retained, and ultimately transmitted.

The organs of sense, more particularly touch, hearing, and sight, usually become highly irritable, and, from lowest to highest animal forms, sensory apparatus gets specialized. By slight alteration in textural qualities functional intensity is superinduced, and touch almost amounts to a sixth sense.

In a number of cases the same group has diurnal and nocturnal representatives; and occasionally, so far as research has yet shown, no good reason can be given for nocturnal habit.

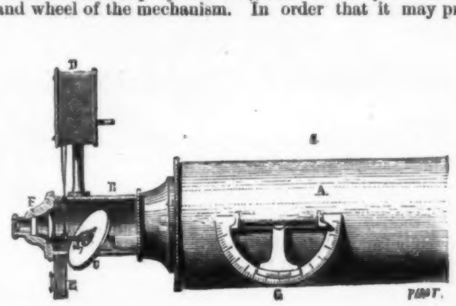
Lastly, communities of animals, like human beings, are doubtless influenced in a variety of ways, and the inherent tendency to aberration, but absolutely from physical causes not demonstrable, may act and react in a manner with which we are yet unacquainted.

THE SCINTILLATION OF THE STARS, AND METEOROLOGICAL PHENOMENA.

SCINTILLATION is said by Arago to consist of frequent changes of luster of the stars—changes which are often accompanied by variations of color. These variations are far from being always perfectly distinct to the naked eye. But the observer perceives them in great number, and with great clearness and brilliancy, when, directing a telescope toward a twinkling star, he causes his instrument to undergo short and rapid vibrations. The image of the star then describes in the field of the telescope a sinuous line, which breaks up into the most brilliant colors, such as red, orange, yellow, green, steel blue, and sometimes violet. Instead of producing the displacement of the image of the star by such vibrations, it is much more convenient to displace the rays themselves in a regular and continuous manner in a fixed telescope. Such an effect is obtained by the aid of the *Scintillometer*, invented by M. Montigny, member of the Belgian Academy, a *résumé* of whose labors we will give in the present article.

This instrument, which is adapted for a Secretan telescope, of 77 millimeters (3 inches) aperture, is composed essentially (Nos. 1 and 2) of a circular glass plate, C, 47 mm. (1·8 in.) in diameter and 6·4 mm. (¼ in.) thick, mounted obliquely at an angle of about 17° upon an axis, I, very near and in front of the eyepiece of the telescope. In this position, the plate must be constantly traversed by the bundle of rays, converging toward the eyepiece in the revolution of the plate around its axis, which is parallel to the optical axis of the telescope, and only 22 mm. (9-10th inch) distant from it. An opening in the center of the plate allows of the insertion therein of a copper ring, through which passes the axis, I, as seen in the figure at No. 2. Upon this axis, at the part where it passes through the opening, are fixed two pivots (one is seen at *b*) perpendicular to it. The extremities of these enter two small holes in the inner surface of the copper ring. Thus arranged, the inclination of the plate in respect to its axis of rotation is regulated by means of the pressure screw, *c*, which is screwed into the extremity of the little piece of copper, *d*; the latter being fixed perpendicularly to the axis. A spring, *e*, presses lightly on the glass disk in a direction opposite to that of the screw, so as to cause it to rest against the point of the latter at a constant angle.

The plate is made to rotate by a mechanism, D (No. 1), which is adapted to the outside of the body of the telescope on the tube, B, which carries the eyepiece. In the engraving this tube is seen open laterally in order to show the details of the arrangement. The rapidity with which the mechanism moves is regulated by a brake, or, better still, by the greater or less obliquity that is given to the spurs of the hand wheel of the mechanism. In order that it may preserve a constant regularity, motion is transmitted to the glass plate by means of an endless elastic thread which runs in the groove of a pulley, H, mounted on the plate's axis. This axis is also furnished with a pinion placed near the pulley, and which communicates motion to a system of two cog wheels that constitute a second mechanism, E (No. 1). The velocity of the latter's rotation is determined by the revolution of a needle upon a dial, and which allows the exact number of revolutions made by the plate per second to be calculated. In the scintillometer that M. Montigny himself constructed, the number of revolutions per second are respectively five and two and a half according to the strength of the scintillation.



M. MONTIGNY'S SCINTILLOMETER.

As a result of the above arrangement, and of that phenomenon known in physics as *lateral displacement*, whereby a ray, R, after passing through the inclined plate, emerges parallel to itself in the direction, R′ (No. 2), that, when the disk turns on its axis, I, the image of a star toward which the telescope is directed describes a perfect circle, *m n*, in its field. If the star undergoes no change, the circumference described forms a continuous line, exhibiting the color of the star. But, if the latter scintillates, this circumference is divided into arcs of different and most brilliant colors, which are continually changing.

In order to enumerate as exactly as possible these colored but very fugitive arcs, M. Montigny has adapted to the focus of the lens at F (No. 1), a special micrometer, which is represented at Nos. 3 and 4. It is composed of three fine threads, crossed diametrically, so as to exhibit in the field of the instrument two opposite sets of four equal sectors, and each of which is equal to a sixteenth of the circular space. This micrometer, being properly illuminated at each observation, is made to coincide either with the center of the circumference described by the twinkling star, or with some point of this circumference. In the first position (No. 3), the number of colors that appear at a given moment in the arc embraced between the two limiting threads of a sector, evidently indicates the number of colors in each sixteenth of the circumference, the latter exhibiting like colored arcs throughout its whole extent. In the second position (No. 4), *half* the number of colors comprised between the threads of the sector indicates the number of changes of color which correspond with a sixteenth of the circular outline. By combining the number of colored arcs shown on the circle with the velocity of the rotary motion communicated to the plate by the mechanism, we calculate the number of changes of color that the image of the twinkling star undergoes in a second of time in the telescope. The result thus obtained evidently indicates the *intensity* of the star's scintillation at the height above the horizon at which it is observed, and this height is immediately determined by means of the small divided circle G, which is adapted to the telescope. There are three causes, to which the variation of the intensity of scintillation is due, and these are: the elevation of the star, the nature of its own light, and the state of the atmosphere.

Observation has shown that during the same evening (that is, under atmospheric influences that vary but little) the intensity of a star's scintillation diminishes in proportion as it rises above the horizon. A law discovered by M. Dufour, of Morges, permits us to convert the absolute intensity, measured at a given height, into a relative intensity, which is that that the same star would have shown if it had been observed at a chosen height (30° for example) above the horizon. The influence of starlight has been determined by the researches of both M. Dufour and M. Montigny, but from two different standpoints, however. The former has established the fact that, all things being equal, red stars scintillate less than white ones, that there are essential differences between the scintillations, and that these differences appear to be derived from the stars themselves. On his part, M. Montigny has since shown, by the aid of numerous observations pursued with all that accuracy which the use of his scintillometer permits of, that the numerical differences which characterize the respective intensities of star scintillation must be attributed to the composition of light proper to each star, and which varies in general with each star, even to apparent equality of color, as we are taught by spectrum analysis. As a result of all his observations, M. Montigny has deduced this important conclusion:

Stars whose spectra are characterized by dark bands and black lines scintillate less than those with fine and numerous spectral lines, and much less than those whose spectra exhibit only a few principal lines.

He has profited by his observations (which, begun in 1870, had embraced more than six hundred evenings before the end of last year), to study the influences of meteorological phenomena on scintillation, by comparing, every evening, the mean intensity of stellar scintillation observed by him, with the data obtained from the Observatory of Brussels.

He observed, first, that the circular trace described by the stars in the telescope of 3 inch aperture, to which his scintillometer is adapted, exhibits characteristic differences according to the state of the sky. If the atmosphere is calm, the trace is narrow and clearly defined; it is called *regular*. Under the influence of rain, it becomes less clear, thicker, *diffuse*. When the atmosphere is disturbed the trace becomes very irregular, and often *fringed*. Finally, under the influence of a squall, it is *punctate*, or it is characterized by more or less marked shrinkages spaced along its outline; in this case the trace is said to be *pearled*.

M. Montigny has ascertained that among the influences which have the most effect on scintillation, that of the rain is by far the most preponderant. At every season scintillation is notably more marked under the influence of rain than under that of dryness. It is much stronger in winter than in summer, and particularly in January and February. It is the least noticeable in June and July. The intensity of scintillation increases progressively at the approach of rain, and especially during rainy days; then it diminishes when the rain ceases. When it rains on the day of observation, scintillation is notably stronger on the next day and the day after. The intensity of the phenomenon greatly increases at the approach of sudden squalls; so that when these great atmospheric disturbances pass in the vicinity of Brussels, it attains a maximum. But in proportion as they recede, scintillation diminishes. The temperature of the air exercises a marked influence on the intensity and character of scintillation, and which is particularly revealed during periods of dryness. When the temperature lowers, particularly in winter, scintillation is strong and the colors exhibit great brilliancy. When it rises its intensity diminishes, and the colors lose much of their brightness, especially in summer. Scintillation is influenced by the degree of humidity of the air, and it varies in the same direction as this humidity during periods of drought as well as during those of rain. It also increases under the influence of fogs, but only in cases where this phenomenon happens on the evening of observation and after it. The snow increases the intensity of scintillation. The presence of the small crystals scattered through the upper regions of the air, and the grouping of which gives rise to the formation of snow, is a sufficient explanation of this increase.

M. Montigny has likewise shown, by the aid of detailed tables, that scintillation is affected by the direction and force of the wind, and that, finally, auroræ boreales exercise considerable of an influence on the phenomenon. He attributes the latter influence to a lowering of the temperature coincident with the appearance of these auroral displays.

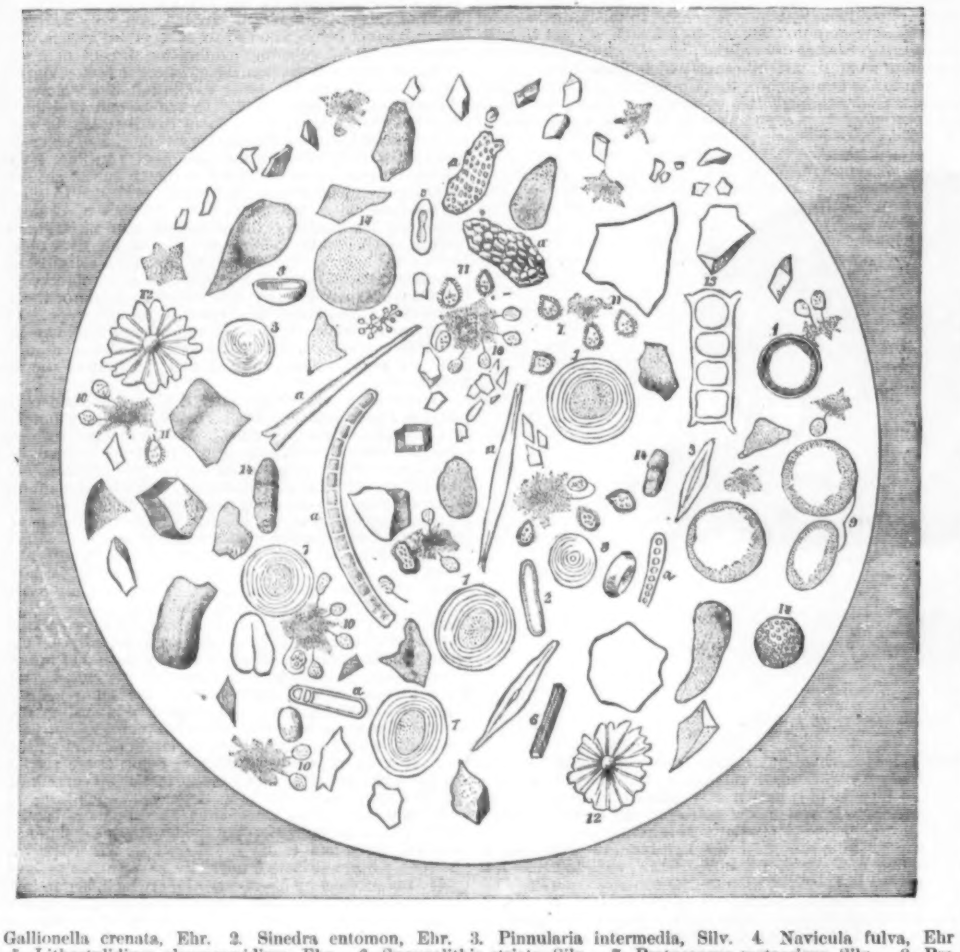
As a result of the researches, of which the foregoing is a brief abstract, M. Montigny draws this important conclusion:

The presence of water in varying quantity in the atmosphere exercises most marked influence on scintillation, and modifies its character to the greatest extent according to the quantity of water, either when the latter exists in the form of vapor in the air, or when it falls to the earth in the liquid state of rain or in the solid state of snow.

We are indebted to *La Nature* for our illustration and description of M. Montigny's apparatus.

DUST SHOWERS.

AN Italian microscopist, Prof. Orazio Silvestri, has recently published an important memoir on the phenomena of dust showers, which are so frequently observed in Italy, and especially in Sicily. These showers have so often been described that we deem it scarcely necessary at the present time to offer any remarks thereupon in reproducing one of the beautiful plates with which Prof. Silvestri's work is illustrated. On referring to the engraving, it will be seen



1. Gallionella crenata, Ehr. 2. Sinedra entomon, Ehr. 3. Pinnularia intermedia, Silv. 4. Navicula fulva, Ehr 5. Lithostylidium clepsammidium, Ehr. 6. Spongolithis striata, Silv. 7. Protococcus meteoricus, Silv. 8. Protococcus meniscus, Silv. 9. Protococcus simplex, Silv. 10. Vorticella convallaria, Ehr. 11. Cyclidium solitarium, Silv. 12. Small star-like object belonging to some vegetable organ. 13. Fragment of Conferva (Gallionella lyrata, Ehr. ?). 14. Fructifications of various forms. *a, a, a.* Fragments of Conferva, epidermis, and fiber of phænogamous plant. The angular fragments represent the mineral portion of the dust. The grumous particles scattered here and there are made up of some organic substance.

PORTION OF DUST SHOWER WHICH FELL IN SICILY. (Magnified 500 diams.)

that the three kingdoms of nature are represented in the imperceptible corpuscles which go to make up these showers. We find therein fragments of all kinds of rocks, microscopic plants, such as algæ, etc., and numerous infusoria.

GEOGRAPHY.

Opening address by CLEMENTS R. MARKHAM, C.B., F.R.S., F.L.S., Sec. R.G.S., F.S.A., President of Section E, British Association.

I PROPOSE to open the proceedings of this section by attempting to place in a clear light the objects and aims of geographers, and the position which their science holds relatively with reference to the other sciences, and positively as a distinct body of knowledge with distinct limits.

Geography is a knowledge of the earth as it is, and of the changes which have taken place on its surface during historical times. These changes explain to us the laws according to which similar changes are now taking place around us. The subject may be considered from various points of view; but my present endeavor will be to introduce to you, through the remarks I propose to make, the papers that will come before you to-day and at our subsequent meetings. I shall try to do this by explaining the practical uses of geographical knowledge, and its importance to us in almost every occupation in which we may be engaged.

Our first work as geographers is to measure all parts of earth and sea, to ascertain the relative positions of all places upon the surface of the globe, and to delineate the varied features of that surface. This great work has been proceeding from the first dawn of civilization, and it will probably be centuries longer before it is completed. Geographers and explorers, surveyors and geodesists, of each generation, work their allotted time, gradually increasing the stock of human knowledge, by enabling other sciences and other branches of inquiry to make parallel advances. For they are all dependent on the accurate measurement and mapping of the earth. Locality is the one basis upon which all human knowledge must rest. Arts, sciences, administration, commerce, depend upon accurate geographical knowledge; and as that knowledge becomes more extensive and more exact, so will every other human pursuit gain increasing light and truthfulness.

We are still very far indeed from an accurate scientific geographical knowledge of even the most civilized countries, while by far the largest portion of the earth's surface is inadequately surveyed, and a smaller, though far from inconsiderable, part is unsurveyed or entirely unknown. In the division of labor, the geodesist produces the accurate large-scale maps which are necessary in thickly populated countries, the topographical surveyor furnishes less exact maps of more thinly peopled and less civilized regions, while the trained explorer forces his way into the unknown parts of the earth.

From the labors of these three classes of workers, we, in this generation, and our descendants for many generations to come, must be content to derive our knowledge; but in the fullness of time the whole earth will be measured and delineated as Hallamshire is now. It is to the furthering of this great work that the geographers of each age devote their energies, and its advancement will increase in rapidity, because, as men become better instructed, there will be more geographers.

The construction of large-scale maps on rigorously accurate principles has as yet made inconsiderable progress. It is only in the countries of Europe and India, and some of our colonies, and in the United States, that it has been commenced. But it is very far from being completed anywhere, and the people of Sheffield have had this fact brought home to them within the last year; for the Memoir on the Yorkshire Coal Field, published by the Geological Survey in 1878, was obliged to stop short with the limits of the county, an artificial and inconvenient line which leaves the southern portion of the field undescribed, entirely because the six-inch survey had not yet been extended over Nottinghamshire and Derbyshire. This circumstance strikes us in two ways. It reminds us that geographical work is far from being completed even in the most populous and civilized parts of our own country, and it also brings the fact home to us that the progress of other sciences is dependent upon the advance of geography.

Where the trigonometrical surveys have not been commenced, we have only those maps which are based on positions fixed by astronomical observations, on cross-bearings and chained distances, and which I call (to distinguish them from the results of trigonometrical surveys) the topographical maps. One of the oldest and most interesting of these maps is the famous atlas of the Chinese Empire, constructed by the Jesuits between 1708 and 1718. But we are also dependent on such maps for our geographical knowledge of all Asia, except India and Palestine, of the Eastern Archipelago, of all Africa and South America, and of the greater part of North America.

Accurate maps are the basis of all inquiry conducted on scientific principles. Without them a geological survey is impossible; nor can botany, zoology, or ethnology be viewed in their broader aspects, unless considerations of locality, altitude, and latitude are kept in view. Not only as the basis scientific inquiry, but also for the comprehension of history, for operations of war, for administrative purposes, and for the illustration of statistics, the uses of accurate maps are almost infinite. M. Quetelet, in one of his well-known letters, declared that such graphic illustration often afforded immediate conviction of a point which the most subtle mind would find it difficult to perceive without such aid. Maps both generalize and allow of abstraction. They enable inquirers at once to detect and often to rectify errors which, if undetected, would affect results and throw calculations into confusion. As an example of the use of maps for administrative purposes, the series constructed by Mr. Edward A. Prinsep, in India, is worthy of notice. They showed the agricultural tribes of a special district arranged according to occupancy of land, political and fiscal divisions, physical features and zones of fertility, productive power as influenced by rain or aided by irrigation, different kinds of soils, acres under different kinds of produce, and lines of traffic. Another most instructive series displays the state irrigation canals acting on improvable waste lands, the depth of wells, the rainfall and zones of drought, and the parts of the country already irrigated. As another noteworthy instance of the use of maps for statistical illustration, I may mention the interesting "Carte agricole de la France," by M. Delesse, which not only shows the extent of arable, meadow, and vine lands and of woods, but the relative value of lands by shades and contour lines of equal revenue. The idea has been adopted by Mr. Ralph Richardson in his map of Mid-Lothian, showing the annual rentals by colors, and of course the colors also indicate the positions of barren mountains, of fertile valleys, and of centers of population. Such maps ought to be far more extensively used than is now the case, for in no other way can economic and industrial facts be so lucidly and clearly, as well as so rapidly, impressed on an inquirer's mind.

The third division in which geographical delineation is classed is that comprised in the labor of pioneer-exploring and discovery. This branch of our subject excites the most interest, because the heroic devotion and gallantry of our travelers is a source of just pride to the nation; and because their perils and hardships, their adventures and discoveries, surround them with a halo of romance. Yet these romantic associations are not confined to the pioneers of geography. Though less known, they equally belong to the more scientific geodesist. In the whole range of exploring narrative, there is nothing more calculated to excite admiration, nothing more touching, than the devotion of Colonel Lambton, the first superintendent of the Great Trigonometrical Survey of India, the old man who was absorbed in his great work for half a lifetime, who wasted away from exposure and hardship, but who, to the last, brightened up to renewed animation and vigor when the great theodolite was before him, and who died at his post in a wild part of Central India. This was sixty years ago, but quite recently the equally heroic death of Captain Basevi was recorded. At 17,000 feet above the sea, in a temperature below zero, and protected only by a light tent, this martyr to science was engaged in the delicate operation of swinging the seconds pendulum. One morning, when gallantly striving to rise from a bed of suffering and to recommence work, he died. Nor do these names stand alone. Assuredly, the more scientific surveyors run equal risks, and deserve equal recognition with their exploring brethren. Still the interest justly attaching to new discoveries naturally commands most popular applause, and the importance of opening up an unknown country cannot well be exaggerated

In this glorious field there are still harvests to be reaped through the bravery and endurance of future travelers. In spite of all that has recently been done in Africa, there is a vast unknown tract to be discovered. In Asia, in New Guinea, in Sumatra and Borneo, in South America, wide regions also remain unexplored. Above all, the greatest problem of this age awaits solution in the far north, and will call forth the best scientific ability, and all the highest qualities of our naval explorers.

Every year new regions are brought within our knowledge, and we are able to welcome the adventurers home, and to add them to the list of geographical worthies. But, with regard to many explorers, there can be no doubt that much more valuable information might be obtained than is now the case. Men, with various vocations, traverse unexplored or little known countries, who, from want of previous training, are unable to lay down their routes or to observe with scientific accuracy and intelligence. There are naval and military officers, missionaries, consular agents, colonial officials and planters, engineers, telegraphers, collectors and sportsmen or persons merely traveling for pleasure, many of whom are led, by business or curiosity, to penetrate into regions of which little is known. It is most important that there should exist, in this country, the ready means of furnishing the necessary training to such explorers; and the subject has recently received serious consideration from the Council of the Royal Geographical Society.

It has been resolved that a course of instruction shall be supplied by the Society to all who are about to visit unknown or little known countries, and who desire such training. As a preliminary measure, the present arrangement is to give such instruction as will enable the pupil to fix positions by astronomical observations, and to lay down his route, but this is only a beginning, and it is to be hoped that, in due time, such a course of instruction will be provided as will enable an intelligent traveler to observe with scientific accuracy, and to bring home really valuable results in various branches of inquiry. It is very desirable that this resolution of the Geographical Society should be widely known, and I trust that the local members of this section will co-operate so far as to bear in mind that this aid is offered by the Geographical Society, when the intention of any native of Hallamshire to visit a distant region comes to their notice. Incalculable good may be done to the cause of geography by a system which will have the effect of making every traveler a scientific and intelligent observer.

The surveying and mapping of the ocean is only second in importance to that of the land; and this work also divides itself into three sections, namely, the coasts surveyed, the coasts partially surveyed, and the unsurveyed coasts. Hydrography will not be completed until all the coasts in the world are included in the first section, which is now very far indeed from being the case. Yet this is not merely a question of science, of the study of the physical geography of the sea, interesting as this branch of our subject has become. Upon the accuracy and completeness of charts hangs the safety of thousands of lives, and the prosperity of commerce in all parts of the world. When it is remembered how much depends upon the work of marine surveys, it must be a subject of astonishment that so many hundreds of miles of coast line, frequented by our shipping, remain unsurveyed; and that even, in some cases, when the surveys have been executed and charts published by foreign governments, they are not accessible in an English form. In the interests of humanity and of the well-being of our trade, the efforts of geographers in urging the completion of marine surveys ought to be cordially seconded by Chambers of Commerce, and by all those whose material interests are concerned in the provision of accurate charts of all coasts visited by our shipping.

(To be continued.)

A NUMBER of prehistoric bronzes, found in ancient Siberian graves, and collected by Seebohm and Wiggins during their exploration of Arctic Siberia, are thought to be from 4,000 to 5,000 years old.